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**Innovations in Defense Acquisition:
Asymmetric Information and Incentive Contract Design**

15 December 2009

by

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14. ABSTRACT

This report continues a research stream initiated in 2007 to apply mechanism design concepts to the DoD?s acquisition transactions. Recognizing the central importance of private information and incentives, mechanism design reflects the decisions made by individuals and institutions based on the information they possess and the incentives they face. The designer chooses the mechanism (institutional structure) that promotes the desired outcome (decision or resource allocation). This research addresses asymmetric information in contract negotiations? eliciting accurate information from a contractor to determine the most cost-effective combination of performance, schedule and cost. During the final contract negotiations, the contractor has the best information about the true cost to deliver a product or service with the desired quality and within the proposed schedule, but has an incentive to misrepresent this information to obtain more favorable contract terms. This research describes a truth-revealing contract structure that has been refined for this specific DoD application and develops a spreadsheet model to implement this structure. The model incorporates a budget constraint and signals when the proposed contract parameters might exceed the budget constraint. It adjusts the cost target range so that total costs satisfy the DoD?s budget constraint while maintaining truthful revelation properties.

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Abstract

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Keywords: Incentive Contracting, Principal Agent, Mechanism Design

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I.   Introduction

Information is a critical element in defense acquisition. Without accurate information about costs, schedule and technical performance, and the trade-offs between them, it is impossible to determine the optimal investment portfolio in defense capabilities or to select the most efficient contractors to deliver those capabilities. Unfortunately, the required information is often private, decentralized and asymmetrically distributed across potential contractors and DoD stakeholders. In addition, stakeholders in the defense acquisition process have conflicting objectives and may have incentives to misrepresent their true information. One of the dilemmas in defense acquisition is how to obtain accurate information from the defense contractors, aggregate the information, and appropriately use it in the defense acquisition process.

This report continues a research stream initiated in 2007 to apply mechanism design concepts to the DoD's acquisition transactions. Mechanism design, as depicted in Figure 1, is also referred to as reverse game theory (Milgrom, 2004; Meyerson, 2008). Mechanism design models the decisions made by actors (individuals and institutions) based on the information they possess and the incentives they face. Recognizing the central importance of private information and incentives, the mechanism designer chooses the mechanism (institutional structure or game) in a way that promotes the desired outcome (decision or resource allocation). In contrast, game theory treats the institutions as inherited and then models the resulting decisions and outcomes. Mechanism-design situations are resolved by motivating the actors to directly or indirectly reveal their private information, allowing the decision-maker to allocate resources appropriately.
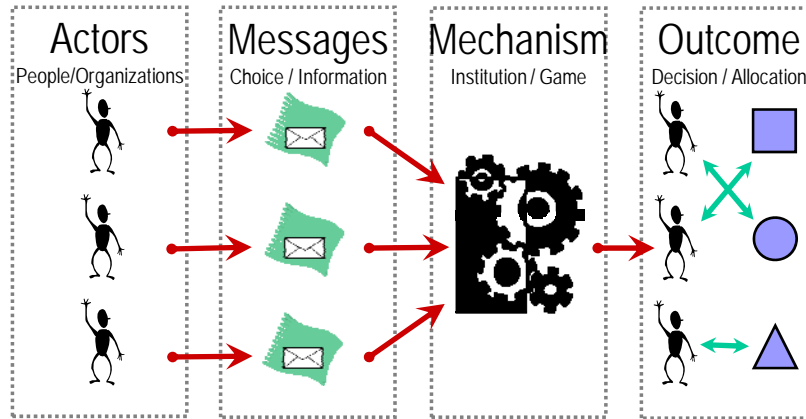
Figure 1. Mechanism Design or Reverse Game Theory

Recent research into mechanism design has considered situations involving asymmetric information and incompatible incentives. This research has addressed incentive contracts as well as market and non-market interactions, including auction designs. The common thread in this research is addressing issues involving information asymmetries and incompatible incentives across stakeholders interacting to accomplish a particular task, e.g., procurement of a defense technology or service.

These information issues involve at least three elements. The first element relates to gathering accurate information from potential defense contractors. Contractors possess private information about their true expected costs and their ability to achieve the government's perceived priorities between cost, performance and schedule. As stated above, it is often in the contractors' best interest to be less than candid about that information, often at the DoD's expense; the DoD would like to obtain accurate information from these contractors. As the DoD obtains information from the private sector, the second information-related issue involves aggregating that information is a useful manner. In contracting, for example, it would help to aggregate the available information about cost, performance and schedule tradeoffs before publishing a formal request for proposals (RFP). That way, the RFP would be informed by comprehensive and accurate information. As the third information-related issue, the DoD must decide if they want to reveal all of the

information they possess. Just as with the contractors, the DoD might choose to strategically reveal information to further their own objectives, often at the contractors' expense.

To illustrate further, consider three situations where information is critical but problematic.

- Suppose the DoD is purchasing a weapon system that involves multiple performance characteristics but is uncertain about the relevant tradeoffs between the technical performance for each attribute, project schedule and cost. Contractors have better information about these tradeoffs but each contractor has a different comparative advantage (each contractor is better at delivering different combinations of performance, time and cost); their incentive is to sway the DoD's preferences in ways that favor their comparative advantage. How does the DoD gather and aggregate accurate information about the possible tradeoffs between technical performance, cost and schedule?

- Suppose the DoD is negotiating a final contract with the winning bidder after a competitive selection process. At this stage, the contractor has the best information about the true cost to deliver the product or service within the proposed schedule but may have an incentive to misrepresent this information to obtain more favorable contract terms. How does the DoD obtain accurate information from the contractor to determine the most cost-effective combination of performance, schedule and cost?

- Suppose the DoD is purchasing a weapon system that involves multiple performance characteristics and knows its preferences over the relevant tradeoffs between the technical performance for each attribute, project schedule and cost. However, the DoD is reluctant to be too specific about how it will weight each attribute in the RFP process for fear of potential contractor protests. Without specific tradeoff information, contractors may propose suboptimal contract outcomes. How should the DoD evaluate the benefits of more accurate information versus the increased risk of protests?

Previous research examined the use of reverse auctions in the DoD's procurement process and developed a two-stage auction mechanism to gather and aggregate truthful information from potential defense contractors about cost, schedule and performance tradeoffs, the first information-asymmetry scenario described above. This report will examine the second information-asymmetry

scenario: eliciting truthful cost estimates from contractors during contract negotiations. Future research will address the third information-asymmetry scenario: the DoD's decision to accurately reveal its contract preference tradeoffs.

A.   Previous Research

The economy has developed several mechanisms to govern the interactions between buyers and sellers (see Figure 2).[1] Traditional markets are most effective when there are many potential buyers and sellers and when products are relatively standardized. In traditional markets, competition between both buyers and sellers ensures that the market establishes an efficient price to balance supply and demand. Negotiation generally characterizes situations where markets are thin and there are few buyers and sellers. Forward auctions are increasingly used in cases in which there is only one seller and several buyers. This trend is evident with the explosion of online auctions, such as e-Bay. Reverse auctions involve a single buyer and several sellers.
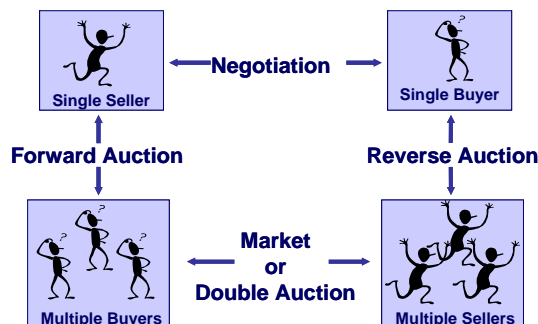
Figure 2.   Alternative Buyer and Seller Interaction Mechanisms

The Department of Defense (DoD) participates in transactions that involve several of these situations. As a consumer of specialized defense products, the DoD operates as single-buyer with anywhere from a single to several potential suppliers, depending on the uniqueness of the defense product. As a consumer of

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[1] A mechanism is the set of rules that govern the interactions between parties in a relationship; in this application, it is the set of rules that govern the interactions between buyers and sellers in defense acquisition.

standard commercial commodities, such as pencils and paper, it participates in markets with many buyers and sellers, though the size of defense purchases often makes the DoD an atypical consumer in these markets. As a result, the DoD should be expected to exploit the full range of transaction mechanisms, from standard market interactions to auctions and bargaining.

B.   Reverse Procurement Auctions

Prior research described the Defense Department's experience with acquisition auctions, identifying the characteristics of the buyers, sellers and products/services exchanged through auctions (Coughlan, Gates & Lamping, 2008). As described above, auction theory characterizes reverse auctions as appropriate for transactions involving a single buyer and several sellers. In contrast, the DoD practice uses reverse auctions for transactions involving products or services in which the government is only one of many potential buyers, including relatively standard price-driven commercial commodities and services. The DoD has effectively substituted the reverse auction and support from commercial electronic reverse auction (e-RA) providers for the market research federal procurement agents conduct when the DoD purchases these items through a more traditional procurement process.

While substantial cost savings are attributed to reverse auctions, it is likely that these savings reflect increases in competition from substituting e-RAs for traditional market research. Competition has two effects: it increases the number of cost estimates, which increases the probability of finding a lower cost estimate; it decreases the sellers' surplus as competition encourages bids closer to actual costs. Data from two e-RA providers, FedBid and USAAVE, indicate that reverse auctions significantly increase the number of suppliers bidding on federal contracts compared to the contractors contacted through traditional market research. Data from FedBid further emphasizes that potential competition might be significantly greater than this because a large number of suppliers are notified about the solicitation, though some

choose to submit "no bid" and others are even less active (Coughlan, Gates & Lamping, 2008).

To extend reverse auctions to more traditional applications, where the DoD is the only or one of few buyers, will generally require a shift toward basing the winning bid on best value as opposed to best price; best value can include price, technical factors and past contractor performance, depending on the buyer's needs and preferences.[2] The buyer must state whether the award will be based on the lowest price or the best value in the solicitation. Depending on the size and complexity of the procurement, the buyer might also provide specific weights for evaluating price, technical factors, timeliness, and/or past performance. Currently, price, delivery time, and past performance are the most common factors used by the federal agencies.

USAAVE can support best-value auctions using a two-step, sealed-bidding process; sellers submit their technical proposal with all other required information (e.g., company qualifications and past performance information) so that the buyer can determine if that vendor is a qualified supplier. Once the evaluation determines a vendor is technically acceptable, they are invited to partake in the reverse auction. USAAVE also has a weighted value function that is particularly useful in determining a best-value award. Non-price factors are evaluated and assigned a subjective adjectival grade in accordance with a predetermined grading scale. After the adjectival rating is assigned to the factors in the vendor's bid, an overall weighting scale is used to calculate a final bid score that is posted with the vendor's bid. Both the buyer and the vendor who submitted the subject bid are able to see these

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[2] *FAR* 13.106-2(4): "For acquisitions conducted using […] a method that permits electronic response to the solicitation, the contracting officer may—(i) […] identify from all[…] offers received one that is suitable to the user, such as the lowest priced brand name product, and quickly screen all lower priced quotations or offers based on readily discernible value indicators, such as past performance, warranty conditions, and maintenance availability; or (ii) Where an evaluation is based only on price and past performance, make an award based on whether the lowest priced of the quotations or offers having the highest past performance rating possible represents the best value when compared to any lower priced quotation or offer."

weightings, which the agency believes helps to prevent protests (Coughlan, Gates & Lamping, 2008; Brown & Ray, 2007).

FedBid has a similar automated best-value weighting tool, but it is currently deactivated because its e-RAs are primarily used for competing price-driven commodities in a simplified acquisition scenario. Delivery schedule is the primary factor federal agencies consider when they want to include factors other than price. In this case, FedBid encourages vendors to submit multiple bids in which the price may be lower for slower delivery times and higher for faster delivery times. The buyer then evaluates and selects the winning bidder by trading off monetary and non-monetary factors as accounted for in the solicitation. The winning bidder may or may not be the "lowest" bidder at the conclusion of the auction, depending on the best-value determination.

One complication in using the best-value approach is uncertainty in setting the appropriate weighting factors. The relevant information is generally distributed across the defense contractors competing to supply product or service. This is the information aggregation problem discussed above.

C. The Iterated Information Aggregation Auction (I^2A^2)

Whether procuring a new aircraft, a desktop computer, or even lawn-care services, there are generally a wide number of quality dimensions, beyond price considerations, over which to measure a product/service offering from a potential contractor. Answering the "what should we procure" question essentially boils down to determining which of all the possible quality dimensions should matter and how much they should matter.

For example, determining which type of aircraft to procure is equivalent to determining the relative importance of each of a myriad of possible quality dimensions such as speed, maneuverability, range, and so on. In turn, the relative importance or "weight" that a procuring organization places on different quality dimensions will determine the types of aircraft offered by contractors and the specific

aircraft that is ultimately acquired. The relative weight placed on each quality dimension also indirectly determines which contractor will ultimately produce the aircraft, with the winning contractor generally being the one capable of providing the greatest "bang for the buck"—"bang" being specifically measured by the weights placed on the various dimensions of quality.

Even if economists were to generally recognize that determining what should be procured is a complex process, it may nonetheless be unclear how the field of economics can contribute to our understanding of the issue. After all, why shouldn't analysis in this initial stage of procurement simply be left to engineers, market researchers, and others? The reason, as we shall see, arises from the fact that determining precisely what should be procured requires procuring organizations to gather and aggregate a broad set of information that meets the following requirements:

- *Incomplete*—No single actor or organization possesses all of the relevant information. The procuring organization may have some understanding of its needs but may possess only limited knowledge regarding the capabilities of current technology and probably even less knowledge about the costs incurred by individual contractors to produce this technology. Each individual contractor, on the other hand, may have a good understanding of its own cost structure and technological capabilities but may possess only limited knowledge about the procuring organization's true needs or about the cost structures and technological capabilities of its competitors.

- *Diffuse*—The relevant information for determining what should be procured is spread across numerous organizations. The full gamut of information about needs, costs, and capabilities is spread among the procuring organization and all of its potential contractors, which could be numerous. A key piece of information about state-of-the-art capabilities, for example, could be possessed by only a single contractor while another key piece of information could be exclusively possessed by a different contractor. Full information aggregation thus requires extracting knowledge from a wide number of organizations—a formidable undertaking for traditional market research methods.

- *Private*—Information possessed by any organization, particularly about costs or capabilities, may be known only within that organization and, moreover, the organization may have little incentive to truthfully reveal

its information. For example, while traditional market research might involve asking a contractor how the procuring organization's needs might best be satisfied by existing technology, the contractor has every incentive to convince the procuring organization that its needs can best be met by technologies in which that particular contractor has a comparative cost or capability advantage. Effective information aggregation requires the creation of incentives for contractors to truthfully reveal their private information.

In other words, the buyer is not always fully aware of all possible capabilities of available technology nor is the buyer fully aware of the precise benefits of these capabilities. Similarly, contractors may have better (or at least different) information about the capabilities of available technology but may have only an imprecise understanding of the benefits of these capabilities for the buyer. Thus, information about the true nature of buyer value is incomplete, diffuse and private.

In this case, the DoD faces a significant information aggregation challenge in determining the optimal mix of product attributes. Contractors have better information about these tradeoffs but each contractor has a different comparative advantage (each contractor is better at delivering different combinations of performance attributes, time and cost); their incentive is to sway the DoD's preferences in ways that favor their comparative advantage. How does the DoD gather and aggregate accurate information about the possible tradeoffs between technical performance attributes, cost and schedule?

This analysis employed the economic methods of mechanism design to develop an iterated procurement auction mechanism which endogenously aggregates information and determines what should be procured, how it should be procured, from whom it should be procured, and at what price it should be procured. The Iterated Information Aggregation Auction (I^2A^2) is a two-stage auction; in stage one, contractors submit preliminary bids based on their prior information about the DoD's preferences and their own performance, schedule and cost tradeoffs (this could be considered a pre-qualification stage) (Coughlan, Gates & Lamping, 2008; Vanden Bos, 2007). The DoD uses the first-stage submissions to update its information about the performance, schedule and cost tradeoffs and incorporates

that information into its published attribute weights in the final RFP. The higher-valued contractors from the first stage are invited to submit final bids in the second stage; the lower-valued contractors are eliminated from the competition in stage two.

Both the first and second auction stages are conducted as generalized, multi-dimensional, second-price auctions. This means that the bids will first be ranked according to the overall value delivered (as perceived by the DoD). The winner in the final auction is the seller who submits the highest value bid. The feature that makes the auction a generalized second-price auction is that the winning seller in the final auction is not paid the price it bid but rather the highest price that the seller *could have* bid and still have won the final auction.

This generalized second-price auction format is employed because it induces truthful revelation of costs. This well-known characteristic of generalized second-price auctions in the current context implies that the optimal strategy for any seller is to submit a bid in which its price is exactly equal to its cost (including opportunity costs or minimum required profits) to deliver a product/service with the performance attributes and schedule submitted in its bid.

While the winning seller will not be announced until after the final auction, it is important to note that bids placed in the first-stage auction are considered binding. If a bid placed in the initial auction actually delivers higher overall value to the buyer than any bid placed in the final auction, then the buyer can (and will) choose that first-stage submission as the ultimate winning bid. Again, the winning seller will be paid the highest price that seller *could have* bid and still have won the final auction. Allowing for a bid placed in the initial auction to be selected as the ultimate winning bid encourages bids placed in the initial auction to be truth-revealing as in the second round. If bids in the initial auction were not binding, a seller would have an incentive to bid a price below cost to increase its chances of being identified as a high-value bidder and participate in the final auction. With binding initial bids, contractors are likely to bid truthfully (setting price equal to cost) (Coughlan, Gates & Lamping, 2008; Vanden Bos, 2007).

Simulation analysis revealed that the I^2A^2 mechanism can potentially increase the DoD's surplus value (price minus true value) by 30% or more compared to the available single-stage auction alternatives. Investigating the performance of the I^2A^2 mechanism under various competitive and information conditions further showed that the mechanism performs comparably well under both high-competition and low-competition scenarios but appears to be most valuable in environments with relatively low information, especially when contractors possess better information about the potential value of a product/service than the government buyer (Coughlan, Gates & Lamping, 2008)

D.   Current Research

The research summarized in this report addresses the second asymmetric information scenario described above: eliciting accurate information from a contractor to determine the most cost-effective combination of performance, schedule and cost during final contract negotiations. During the final contract negotiations, the contractor has the best information about the true cost to deliver a product or service with the desired quality and within the proposed schedule but may have an incentive to misrepresent this information to obtain more favorable contract terms. This research describes a truth-revealing contract structure that has been refined for this specific DoD application and develops the contracting guidance to implement this structure. This broadens our research on asymmetric information and incompatible incentives to include contracting mechanisms designed for situations where auctions are inappropriate or impractical.

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II. Principal-Agent Relationships in Defense Contracting

Contracting situations, such as the one described above, are generally characterized as principal-agent relationships. Principal-agent relationships are relatively common situations in both the public and private sectors (Eisenhardt, 1989; Milgrom & Roberts, 1992). A principal-agent relationship occurs when one organization (the principal) wants to employ another organization (the agent) to perform a task or service. Problems arise in these relationships because the principal and agent typically have different objectives. In addition, both parties have incomplete information, and it is usually costly or impossible for the principal to perfectly monitor the agent's performance. As a result, agents can engage in strategic behavior to further their objectives at the principal's expense.

For example, consider the defense procurement process for major systems or developmental items (items that are not available off-the-shelf). The federal procurement process, as specified in the *Federal Acquisition Regulations*, involves several steps: selecting the contractor, negotiating the contract, performing the work, evaluating the contractor's performance, and giving the contractor the appropriate payments. The procuring agency initiates the process by publishing a Request For Proposals (RFP). The RFP specifies the system's technical requirements, program schedule, and any other pertinent information. All interested private firms are invited to respond to the RFPs by submitting a proposal. The proposal describes the firm's technical approach, schedule, projected system performance, and estimated cost. After evaluating all proposals, the winning contractor is selected. Selection criteria include technical merit, cost, schedule, managerial approach, and the demonstrated capability to perform the task as proposed. The winning contractor is selected by assessing each proposal in all relevant dimensions. Comparisons necessarily involve a degree of subjectivity.

After completing the selection process, the procuring organization (principal) and the winning contractor (agent) enter negotiations. During this phase, the principal and agent negotiate a contract that specifies the technical objectives, program schedule, cost targets, allowable costs and profits, and performance evaluation criteria. The negotiations are certainly influenced by the contractor's proposal, but they are not bound by the proposal terms. After reaching an agreement, the work is performed, evaluated, and the appropriate payments are made.

A.   Overview of Principal-Agent Problems

Principal-agent problems arise because both parties have different incentives throughout this process. Presumably, the principal would like to minimize cost for a given performance level and program schedule. The principal may also have other objectives such as maximizing the probability that the program is funded, maximizing the probability of completing the program within the cost target, maximizing the organization's budget, etc.

On the other hand, the contractor is presumably motivated by profits. Because information is incomplete and the principal cannot perfectly monitor or evaluate the agent's performance, the agent has an incentive to behave strategically to increase profits. In the process described above, there are several areas where strategic behavior can enhance the contractor's profits. First, the contractor has an incentive to be optimistic in the proposal process. This increases the probability of winning the contract but does not irreversibly compromise the agent's negotiating position. Depending on the contract form, the contractor may have an incentive to be overly pessimistic during negotiations in order to make the contract terms more favorable. Similarly, the contractor may have an incentive to overstate the level of effort applied during the program. Finally, there is no incentive to control results that are not specifically included in the evaluation process (e.g., operations and maintenance costs).

Incomplete information and divergent objectives create a sense of mistrust between the principal and the agent. As explained above, agents have an incentive to exploit their private information to further their objectives. Because the principal and agent have different objectives, this may not be in the principal's best interest. Unfortunately, it is difficult to detect misrepresented or biased information when the players have different areas of expertise. Therefore, it is natural for the principal to mistrust the agent's data, reported performance, and management decisions.

B.   Incentive Contracting and Regulatory Mechanisms in Principal-Agent Relationships

There are both exogenous and endogenous responses to this problem. The exogenous response is for the principal to impose performance standards or behavior norms on the agent and monitor the agent's behavior for conformance. The endogenous response explicitly recognizes the opportunity for strategic behavior and counters this incentive through appropriately designed contract incentives. The contract incentives should reflect the principal's circumstances, including the information available, the observable variables, and the principal's authority. Endogenously deriving the incentive structure can produce a contract that aligns the agent's self-interest with the principal's objectives.

Defense procurement programs have typically followed the exogenous response. There are strict regulations regarding management oversight, data requirements, and independent cost and performance verification (e.g., government should-cost analyses, independent testing, Government Accountability Office (GAO) analyses, etc.). These efforts have increased the procurement bureaucracy but have not alleviated the fears of deception, as indicated by the continuing stream of federal procurement scandals and reforms (Gates, 1989). In addition, obtaining independent information is expensive. Thus, analysts rely heavily on data provided by the organization being evaluated.

The principal-agent literature on incentive contracting and designing regulatory mechanisms recommends an endogenous response (Baron, 1989; Besen

& Terasawa, 1987). This literature describes how the principal can design a selection and contracting procedure (or regulatory mechanism) that selects the most efficient agent and encourages the agent to act in the principal's best interest. For example, to select the most efficient agent, an endogenously designed contracting mechanism must induce the agents to truthfully reveal *ex ante* their expected costs, schedule, and technical performance. This can be accomplished by structuring the contract incentives so that the contractor maximizes its expected profits by telling the truth. In other words, the contract incentives should ensure that the contractor maximizes its expected profits by reporting low expected costs if they are low-cost contractors and by reporting high expected costs if they are high-cost contractors.

Similarly, the contract should contain incentives that reward the contractor for achieving the principal's objectives. The principal's objectives might include minimizing the cost of achieving the technical performance and schedule targets while balancing marginal changes in cost, performance, and schedule according to the principal's priorities. For example, if the contract includes an award fee, the relative weight placed on cost, performance, and schedule in calculating the fee should reflect the principal's priorities between these factors. These types of "incentive-compatible" relationships are substitutes for monitoring the agent's performance and reports.

Endogenously derived incentive contracts have to balance three sometimes contrary factors: moral hazard, adverse selection, and risk aversion (Besen & Terasawa, 1987). Moral hazard arises when the agent's decisions are not in the principal's best interests. For example, insurance introduces moral hazard because the insured may reduce their risk-avoiding behavior (i.e., take fewer precautions than the insurance provider would consider optimal). In contracting, cost-sharing introduces moral hazard. If the principal and agent share deviations from the contract cost target, then it reduces the agent's incentive to control cost. If cost deviations are shared 50/50, the agent only captures half of any cost savings. Therefore, the agent will only invest in cost-reducing activities if the expected cost savings are at least twice as large as the required expenditure. There is no moral

hazard in fixed-price contracts (assuming no renegotiation) while moral hazard is most troublesome in 100% cost-reimbursement contracts.

Adverse selection refers to situations where the selection process encourages outcomes that the principal considers unfavorable. "All you can eat" buffets are an example of adverse selection. As the fixed price increases, consumers who eat the least will be the most likely to stop patronizing the restaurant. Therefore, increasing the price increases the cost per customer. This is an unfavorable outcome from the provider's viewpoint. In contracting, adverse selection results if the selection process fails to identify the most efficient supplier. Adverse selection is minimized if the principal awards a fixed-price contract to the agent with the best proposal and there is no possibility of renegotiating the proposal. Under these circumstances, the initial estimates provide a valid indication of the actual expected costs. Adverse selection is more of a problem when the initial cost estimate loses validity as with cost-sharing contracts and frequent renegotiation. The selection process can be distorted if initial cost estimates are not accurate indicators of the contractor's expected costs.

Risk aversion refers to situations where decision-makers would pay to avoid uncertain outcomes. Risk-averse people buy insurance and would accept less than $.50 rather than take a 50/50 chance of receiving $1.00 or $0. Risk-averse agents will demand a premium to undertake a risky activity. In contracting, where the actual costs of fulfilling the contract are uncertain, agents would have to be paid a risk premium to accept a fixed-price contract. As the government agrees to absorb more of the cost uncertainty (by increasing the government's cost-sharing percentage), the required risk premium decreases. The government bears all of the cost risk in 100% cost-reimbursement contracts, so the risk premium falls to zero.

Thus, endogenously designed incentive contracts must strike a balance between moral hazard, adverse selection, and risk aversion. The contract design problem is further complicated by equity and efficiency considerations. Equity primarily concerns the distribution of income between producers and consumers.

Efficiency has at least three dimensions: does the agent use the appropriate input mix (capital/labor ratio); does the agent apply the appropriate level of effort; does the agent produce an efficient output level (i.e., the level of output produced in a perfectly competitive industry)?

C.   Literature Review: Incentive Contracting in Principal-Agent Relationships

Simultaneously considering all of these factors in designing selection and contracting mechanisms is extremely complex, and it is difficult to discern the impact that each factor has on the optimal contract design. Therefore, the early literature typically focuses on specific aspects of the issue, starting with stylized descriptions that lead to tractable solutions and gradually adding more complexity.

In an effort to develop federal mechanisms for regulating natural monopolies, Demsetz (1968) provided one of the first attempts to address moral hazard and adverse selection. In his model, Demsetz assumes that there are several potential suppliers. Firms are risk-neutral and each firm knows its own production costs. The regulator knows the market demand. Demsetz's basic premise is to replace competition within the market with competition for the market. He proposes two mechanisms. In the first mechanism, firms bid for the right to be the monopolist. The winning firm is allowed to charge the monopoly price and earn monopoly profits. This mechanism selects the most efficient producer and the monopolist uses the most efficient production technology. However, the output level is inefficient. The firm earns monopoly profits by producing less and charging a higher price than would be observed in a perfectly competitive industry (though most of the monopoly profits are recaptured by the regulator in the bidding process, assuming the difference between the first and second most efficient firms is not too large). Because the firm has monopoly power, there is no moral hazard problem.

Demsetz's second mechanism allows firms to compete on the basis of price. Firms bid on the price they would charge for their output. The lowest bid wins and the firm has to fill all demand at that price. This mechanism also selects the most

efficient producer and there is no moral hazard. The output level is between the competitive industry and monopoly results, so there is an increase in efficiency. However, prices are not responsive to changes in costs, so efficiency is not guaranteed if costs are uncertain or if they change over time.

Loeb and Magat (1979) modified Demsetz's first approach to ensure an efficient level of production. In particular, firms bid for the right to be the monopoly supplier and the winning firm is paid the sum of the producer and consumer surplus. This mechanism selects the most efficient firm; there is no moral hazard because the firm uses the most efficient combination of resources, and it produces the efficient level of output. Furthermore, if an appropriate auction is used, most of the firm's monopoly profits are recaptured through the bidding process (assuming the difference between the first and second most efficient firms is not too large).

Baron and Myerson (1982) modified Loeb and Magat's model to consider cases where auctions cannot be used to redistribute income from producers to consumers (e.g., there is only one potential supplier or the winning agent has already been selected). The agent would capture all consumer surplus without an auction in Loeb and Magat's model. Baron and Myerson address this equity issue by using a two-part pricing mechanism: a per-unit charge and a lump-sum transfer payment. Once the principal and agent agree on a per-unit charge, the agent must satisfy all demand at that price. This determines the value of the producer and consumer surplus that is available for redistribution. The lump-sum transfer payment (which can be negative) ensures that the firm earns sufficient profits to voluntarily participate in the relationship (individual rationality) and determines the final distribution of the surplus between producers and consumers. The principal's (regulator's) objective is to maximize the sum of consumer surplus and profits, but profits are weighted by a scalar that can assume any value between zero and one. The optimal distribution depends on the relative weight that the principal attaches to consumer and producer surplus. The model assumes that the principal tends to place more emphasis on consumer surplus than on the firm's profits (this can be interpreted as either emphasizing consumers over producers or as reflecting the fact

that there is a social cost associated with income transfers between consumers and producers).

In this model, the per-unit charge induces the firm to produce the optimal output while the transfer induces the firm to truthfully report its marginal costs. To induce truthful reporting, the transfer increases as reported marginal costs decrease. This counterbalances the firm's incentive to overstate its marginal cost and mislead the principal so that the regulated price is set closer to the monopoly price.

Assuming that the firm is risk-neutral and has constant marginal costs (which are known to the agent but not the principal), Baron and Myerson derive an expression for the optimal transfer payment and per unit charge. If the principal places equal value on consumer surplus and profits (i.e., the scalar weight on profits is equal to one), the optimal price is equal to the firm's marginal cost. Because the transfer payment ensures truthful revelation, the cost reported by the firm is the actual marginal cost. This is identical to the Loeb and Magat price, ensuring an efficient input mix and output level. The optimal price decreases as profits are deemphasized in the principal's objective function. This results in an inefficient output level (reduces the sum of producer and consumer surplus) but increases the consumers' surplus. Introducing this inefficiency is optimal if the principal places a higher value on the consumer. Thus, the optimal mechanism depends on the tradeoff between efficiency and the consumers' gain.

Laffont and Tirole (1986) consider a single potential supplier, as in Baron and Myerson, but the firm is risk-averse. Risk aversion creates a problem when the firm doesn't know its actual costs *ex ante* but only knows the cost distribution. In addition, the firm can reduce its expected cost by expending extra effort (effort shifts the cost distribution). Effort reduces the firm's utility. Furthermore, the principal cannot measure the firm's effort. This creates a moral hazard problem. The principal's objective is to maximize the un-weighted sum of the producer and consumer surplus minus the social cost of arranging transfers from the government

to the firm. The optimal mechanism balances risk aversion, moral hazard, truthful revelation, and equity.

To eliminate moral hazard, the principal can use a fixed-price contract. The firm will apply the optimal cost minimization effort if it captures all the benefits of those efforts, as in a fixed-price contract. However, the firm bears all of the cost risk under a fixed-price contract, and it has an incentive to overstate expected costs. The only way to get truthful revelation with a fixed-price contract is to give the producer the entire producer and consumer surplus, as in Loeb and Magat. Unfortunately, this is considered inequitable. An auction to transfer income from producers to consumers is not feasible when there is only one supplier, so equity must be addressed through a lump-sum transfer payment, as in Baron and Myerson. Transfer payments have a social cost in the Laffont and Tirole model. Therefore, fixed-price contracts successfully address moral hazard but not risk aversion, truthful revelation, or equity.

To address risk aversion, the principal and agent should share deviations between predicted and actual costs. Furthermore, cost sharing can be used to induce the firm to truthfully report its expected costs. The firm has an incentive to overstate its expected costs. To counterbalance this, the cost-sharing rate should decrease as the cost estimate increases. This encourages truthful revelation without granting the agent the entire producer and consumer surplus. Thus, it minimizes the transfer payments, and associated social costs, required to achieve an acceptable degree of equity. Unfortunately, cost sharing introduces moral hazard. Under a cost-sharing arrangement, a firm will not apply the optimal effort to minimize costs. If costs are not minimized, prices will be inefficiently high and the level of output will be below the efficient level.

Thus, Laffont and Tirole conclude that truthful revelation, risk aversion, and the social cost of income transfers imply that a cost-sharing mechanism is optimal. The cost-sharing ratio must balance these considerations against the higher costs and lower outputs that result from the moral hazard problem. The exact

specification of the cost-sharing mechanism depends on the extent of the firm's risk aversion compared to the firm's disutility from cost-reducing efforts.

Other models have incorporated several additional factors. McAfee and McMillan (1986) modify Laffont and Tirole's model to include adverse selection (several potential suppliers) and a predetermined production quantity (inelastic demand). The principal's objective is to minimize the buyer's costs. Riordan and Sappington (1987) modify McAfee and McMillian's model by making the quantity demanded increase as price decreases and by limiting the principal's ability to accurately observe the agent's actual costs. Finally, Baron and Besanko (1987), among others, consider multi-period relationships. In a multiperiod relationship, it is particularly important to consider the principal's ability to commit, *ex ante*, to a particular mechanism when it may be in the best interest of both parties to renegotiate the contract *ex post*. The problem with renegotiation is that it alters the agent's *ex ante* incentives and changes the terms of the initial agreement. The principal is generally better off if it is possible to make a firm commitment to the initial arrangement and not renegotiate.

In general, the results in these models follow a similar pattern. Unit prices and transfer payments can be used to induce truthful revelation and to address moral hazard, adverse selection, risk aversion, and equity (income distribution). However, solutions to these problems are frequently inconsistent with one another, and they are generally achieved at the expense of economic efficiency. The optimal mechanism seeks to establish the appropriate balance between all factors, based on their relative importance and the principal's objectives.[3]

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[3]For other interesting extensions to this literature, see Baron (1989) and Besen and Terasawa (1987).

D. The "Contract Environment" Versus the "Procurement Environment"

The preceding discussion indicates that the optimal contract structure depends on the particular circumstances of the relationship in question (the "contract environment"). The contract environment is generally dictated by the characteristics of the principal, the agent, and the item being procured. For the most part, it cannot be changed. Characteristics of the contract environment include: the information observed—both *ex ante* and *ex post*—by the principal and the agent (fixed costs, variable costs, level of effort, demand or benefits, etc.), the principal's ability to monitor the agent's performance, the principal's and the agent's risk preferences, the duration of the relationship (single or multiple periods, one time or recurring), the level of competition among agents, and the ability to commit to a particular contract eliminating the possibility for renegotiation. Applying the ideas described in the literature on incentive contracting and regulatory mechanism design requires understanding the contract environment.

Applying these ideas to defense procurement processes also requires understanding the regulatory or "procurement environment" (i.e., the institutional framework surrounding the procurement process). The procurement environment includes the structure of the organizations involved, the decision-makers' objectives and criteria used to evaluate their performance, and the regulations or policies governing the process. For example, different types of federal procurement items involve different organizations and are governed by different procurement regulations. Similarly, different private organizations have different organizational/institutional structures, performance-evaluation criteria, and procurement policies.

Unlike the contract environment, the procurement environment is not dictated by inherent characteristics of the principal, the agent, or the procurement item. It is determined by the principal's institutional practice and generally sanctioned by law or institutional tradition. In most cases, there is substantial resistance to radically

changing these institutions. Therefore, practitioners typically consider the procurement environment as a given, with the possible exception of modest modifications.

This can help explain why the literature on incentive contracting and regulatory mechanism design has not gained widespread practical application despite a wealth of theoretical work.[4] Incentive contracting theory generally treats the procurement environment as malleable and tailors it to match the contracting environment. Contracting practitioners consider the procurement environment fixed. They look at the incentive contracting models and complain that the theory does not capture the reality of their environment. Application failures are essentially failures in relating the contracting environment and the procurement environment. It may be necessary to design incentive contracts on a case-by-case basis, considering both the contracting and the procurement environment. Unfortunately, the case-by-case nature of these applications makes it difficult to incorporate incentive contracting theory into standardized federal procurement regulations or private procurement institutions. Because procurement practitioners tend to rely on standardized procedures, it is natural to expect resistance to adopting these theoretical concepts.

This report attempts to help bridge the gap between theory and practice for at least one form of a contracting relationship. It develops an operational tool, the Truth-revealing Incentive Mechanism (TRIM), to help the government obtain more accurate cost estimates and control program costs (Pupich & Lewis, 2007). The TRIM is structured so that revealing the true estimated cost offers the contractor the highest potential fee for the contracting situation addressed in this research.

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[4] Kornhauser (1986) discusses some applications.

III. Principal-Agent Relationships in Cost-Plus-Incentive-Fee Contracts[5]

As described above, principal-agent relationships are characterized by information asymmetries and incompatible incentives. Information asymmetries involve differences between the principal and agent in the information to which they are privy. In the contracting context, for example, the agent has better information than the principal about the cost and time required to deliver the proposed product or service. The principal and agent also have different incentives; the principal wants to minimize the cost to deliver the product or service within a time schedule; the agent is motivated to maximize profits. The information asymmetry provides the agent some leverage in dealing with the principal; the incompatible incentives provide the motivation to exploit that leverage.

Principal-agent problems exist in most contractual relationships, reflecting differences in the principal and agent's objectives. This chapter identifies principal-agent problems in the DoD's contracting environment and explains how these problems enable contractors to engage in strategic behavior to further their objectives at the Government's expense. Agents can most easily exploit principal-agent relationships when using cost-reimbursement contracts, so this research focuses on cost-reimbursement contracts.

The Government uses cost-reimbursement contracts when there is a high level of uncertainty and the contractor is unwilling to assume risk under a fixed-price contract. In a cost-reimbursement contract, the Government accepts at least some of the cost and performance risk by reimbursing the contractor for all allowable costs incurred in performing the contract, up to a specified limit, and providing a profit of fee in addition to costs. The contractor agrees to give their "best effort" to achieve the contract requirements within the maximum contract price.

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[5] This discussion draws heavily on Pupich and Lewis (2007).

There are several types of cost-reimbursement contract structures; the most common include Cost-Plus-Fixed-Fee (CPFF), Cost-Plus-Award-Fee (CPAF) and Cost-Plus-Incentive-Fee (CPIF). A CPFF contract reimburses the contractor for all allowable costs and pays a predetermined, fixed fee for the contractor's best effort contract performance (*FAR* 16.306). A CPAF contract ties the contractor's profits to the contractor's performance in such areas as quality, timeliness, technical ingenuity, and cost-effective management. The award fee paid is determined by the government's judgmental evaluation of the contractor's performance in terms of the criteria stated in the contract. The methodology for determining the award fee is a unilateral decision made solely at the government's discretion (*FAR* 16.405-2).

A Cost-Plus-Incentive-Fee (CPIF) contract ties the contractor's profits to the contractor's performance by an objective, formulaic relationship. The CPIF contract establishes a target fee that is adjusted by a formula based on the relationship between actual cost and the target cost. The contract specifies the target cost, a target fee, minimum and maximum fees, and a fee adjustment formula. After contract performance, the contractor's fee is determined in accordance with the formula (*FAR* 16.405-1).

This discussion will focus on CPIF contracts with the incentive fee based on cost performance, though the incentive fee could extend to other dimensions. It will also focus on negotiation with a single contractor, either as a sole-source provider or as the winning contractor from a competitive solicitation process. Negotiation with a sole-source contractor represents a relatively simple case with which to illustrate these concepts. Research has addressed more complicated cases but those results are correspondingly more complex (Baron, 1989).

A. Traditional CPIF Contract Structure

The key elements in structuring a traditional CPIF contract, where the incentive is cost-based, are the target cost (i.e., the most likely outcome) and associated incentive fee, the cost-sharing rations for cost under- and over-runs, and the maximum and minimum allowable fees. The contractor receives the projected nominal incentive fee if actual cost equals the contract's target cost. The incentive fee falls to its minimum value if actual costs rise to their maximum allowable value; the incentive fee is maximized if actual costs fall to their lowest expected value. The contract design must determine the projected nominal target fee (if actual costs equal target costs) and the corresponding cost-sharing ratios for cost over-runs and under-runs, and the minimum and maximum allowable incentive fees. The cost-sharing ratio for cost over-runs (under-runs) is set so that the award fee is minimized (maximized) at the maximum (minimum) allowable cost. Given this contract structure, the contractor's expected profits as a function of actual costs can be pictured as in Figure 3.
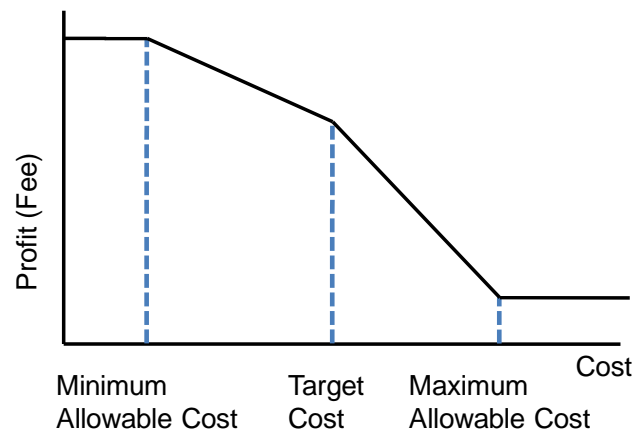
Figure 3.   CPIF Contract Structure

Frequently, the incentive fee pool is set as a percent of the target cost (e.g., 10%). The contract negotiations center on setting the contract's target cost, target incentive fee pool and maximum and minimum allowable costs and fees (or

effectively the contract under- and over-run cost-sharing ratios).[6] If the incentive fee pool increases with the target cost and the cost-sharing ratios are unchanged, as is typically the case, the DoD and the contractor have diametrically opposed incentives: a higher target cost increases the incentive fee pool and the contractor's chances of hitting the target cost. As shown in Figure 4, the contractor's profit (award fee) increases with the target cost for any given actual cost.
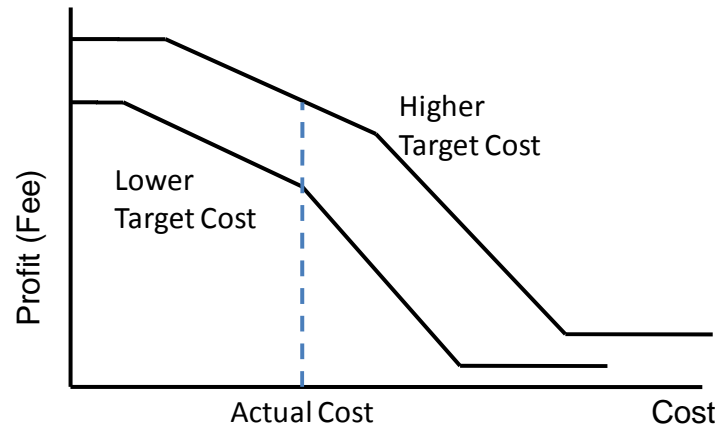
Figure 4. Asymmetric Incentives with Higher Target Costs

To formally describe the contracting problem, let:

C_T = Target Cost,

C_A = Actual Cost,

$A(C)$ = Total Available Incentive Fee as a Function of C, and

$\mu(C)$ = Cost-sharing Ratio as a Function of C.

The agent's profits, $\prod(C_T, C_A)$, are a function of both the target and actual costs. In particular, for costs between the maximum and minimum allowable levels,

$$\pi(C_T, C_A) = A(C_T) + \mu(C_T)[C_T - C_A]. \tag{1}$$

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[6] For simplicity, the remainder of this discussion will assume that the cost under- and over-run sharing ratios are equal (i.e., that the target cost is at the midpoint of the maximum and minimum expected costs).

The DoD and the contractor negotiate over C_T, $A(C)$, $\mu(C)$ and the minimum and maximum allowable costs (and fees). The agent's objective is to select C_T so as to maximize $\pi(C_T, C_A)$. Clearly, if $A(C_T)$ increases with C_T and the cost-sharing ratio remains the same, the contractor has an incentive to maximize C_T. In this case, the principal (the DoD) and the agent (the contractor) have opposing incentives in the negotiation; the contractor also has better information about its true expected costs.

The fact that there is asymmetrical information places the Government in a disadvantaged negotiating position. The Government can determine "should" costs for the program by developing internal and independent government cost estimates and using historical data from procurement projects of similar in size and complexity. The contractor can more accurately estimate "expected" costs, reflecting the contractor's best cost estimate considering the quantity and quality of resources the contractor expects to devote to the program. Only the contractor knows if the contract's negotiated cost is efficient. The Government currently counters this asymmetric information using Government subject-matter experts to evaluate the contractor's proposal, in terms of both effort and cost, without knowing the contractor's true information. The contractor's proposed cost and the contractor's actual cost can be two very different values.

B. An Alternative CPIF Structure

Developing a revised award scheme for this procurement can be thought of as a two-step process: setting the appropriate target cost and then structuring the incentive fees so that the agent's decisions reflect the principal's priorities. Each will be discussed in turn.

To maximize the award fee's impact, the target cost should be related to the project's true expected cost. Too high of a cost target would not encourage the contractor to seek more efficient approaches; too low of a cost target would essentially guarantee that the contractor would exceed the upper cost limit, making the cost incentive virtually meaningless. Presumably, the agent has better

information than the principal about the true expected cost. Therefore, the principal should not set the target cost; the agent should select it.

The principal should provide the agent with a menu of contracts, each with a different target cost and award structure, and let the agent choose the most suitable target cost. However, in developing the menu of contracts, the principal should structure the incentive fees so that the agent picks the contract that most closely reflects the agent's true expected cost. In other words, the award fee structure should ensure that the agent maximizes expected profits by choosing a low-cost target if expected costs are low and by choosing a high-cost target if expected costs are high. Structuring the contract in this manner encourages the agent to reveal its expected cost and allows the principal to appropriately target the cost incentives.

The Appendix to this report derives two general conditions for an incentive structure to ensure the agent will reveal true expected costs. First, the agent's liability for deviations between actual and target costs should decrease (or at least not increase) as the cost target increases. As the target cost increases, cost under-runs become more likely; as the target cost decreases, cost over-runs become more likely. If the contractor shares in any cost under-runs or over-runs, there is a natural incentive to negotiate a high-cost target. This natural incentive is at least partially mitigated by decreasing the sharing ratio when under-runs are more likely (i.e., when the cost target is high) and increasing it when over-runs are more likely (i.e., when the cost target is low).

Second, the total award fee should increase as the cost target decreases. This reinforces the incentive not to overestimate expected costs. However, it is important to relate adjustments in the award fee pool to the cost-sharing ratio. If agents overstate costs, they receive a share of the resulting cost under-runs; the total award fee should be reduced by an amount exceeding the agent's share of the expected cost under-run to counterbalance this incentive. Similarly, if agents understate expected costs, then the award fee increases; the increase in the award

fee should be less than the increase in the agent's share of the expected cost over-run to counterbalance this incentive.

In this alternative contract structure, incentives are structured so the agent earns the highest fee if they choose the contract with a target cost equal to their expected costs. The mathematical relationship between the target fees, target costs, and share ratio make the fee lost by over-running the target cost greater than the fee gained by selecting a lower target cost. Reciprocally, the fee gained by under-running the target cost is less than the potential fee gained by selecting a lower target cost. The relationship between target cost, share ratio, and target fee make the contract terms truth-revealing.

1.   Truth-revealing Incentive Mechanism (TRIM) CPIF Contract Structure

Based on the preceding discussion, a truth-revealing contract incentive structure can be developed that encourages the agent to reveal its true expected costs. The key elements in developing this contract structure include the feasible range of expected contract costs, the appropriate range of cost-sharing ratios given the project's risk, and the minimum profit required for the agent to voluntarily accept the proposed contract (individual rationality). These elements are illustrated in the hypothetical contract menu depicted in Table 1.

Suppose the Government's should-cost analysis projects an expected $4.0 million contract cost, with feasible costs ranging from $2.6 million to $5.4 million. The risk inherent in this project suggests the agent should bear between 25% and 60% of any cost under-runs/over-runs. Finally, the agent demands a minimum 7.5% profit (fee) to accept this contract. These conditions are reflected in Table 1. The cost target in column 1 ranges from $2.6 million to $5.4 million. The cost-sharing ratio in column 2 ranges from 60% to 25%. As described above, the higher cost-sharing ratio is associated with the lower cost target; it is harder to realize cost under-runs with lower cost targets so agents should be more generously rewarded. Finally, the minimum profit (incentive) fee pool ($300,000), associated with the

highest feasible contract cost target, is 7.5% of the cost target to ensure individual rationality.

Table 1. TRIM CPIF Contract Structures

Cost Target ($1,000)	Share Ratio	Profit Pool ($1,000)
$2,600	0.600	$1,490.0
$2,800	0.575	$1,372.5
$3,000	0.550	$1,260.0
$3,200	0.525	$1,152.5
$3,400	0.500	$1,050.0
$3,600	0.475	$952.5
$3,800	0.450	$860.0
$4,000	0.425	$772.5
$4,200	0.400	$690.0
$4,400	0.375	$612.5
$4,600	0.350	$540.0
$4,800	0.325	$472.5
$5,000	0.300	$410.0
$5,200	0.275	$352.5
$5,400	0.25	$300.0

The remaining entries in the profit pool column are computed from this first entry as follows: the increase in the profit pool equals the decrease in target cost times the average of the two associated cost-sharing ratios. For example, the award fee pool increases by $52,500 as the cost target falls from $5.4 million to $5.2 million.

$$\Delta Profit\ Pool = -\Delta Target\ Cost * Average\ Cost\ Share\ Ratio$$

$$\$52,500 = -\{(\$5,200,000 - \$5,400,000)\left(\frac{.275 + .25}{2}\right)\}$$

Consider the agent's options given this contract structure. Suppose the agent's actual costs are $4 million. If the agent selected the contract with the $4 million cost target, its incentive fee would equal $772,500. Instead suppose the principal and agent negotiated a higher cost target—$5 million, for example. In this case, the agent would receive $410,000 as its baseline incentive fee, plus 30% of any cost under-run. If actual costs are $4.0 million, then the agent's share of the cost under-run is $300,000 (= 0.3 * $1,000,000). The agent's total incentive fee would be $710,000 (= $410,000 + $300,000), $62,500 less than the truthful contract option. Instead suppose the agent accepts a lower cost target—$3 million, for example. In this case, the agent would receive $1,260,000 as its baseline incentive fee but pay 55% of any cost over-runs. If actual costs are $4.0 million, the agent's share of the cost over-run is $550,000 (= 0.55 * $1,000,000). The agent's total incentive fee would be $710,000 (= $1,260,000 - $550,000), again $62,500 less than the truthful contract option.

Adopting the contract structures outlined in Table 1, Figure 5 compares the agent's profits as actual costs vary for three different cost targets: $3, $4, and $5 million. If the agent expects actual costs to equal $3 million, then Figure 5 indicates that the agent's profits are highest under the contract with a $3 million cost target. The same consistency holds between expected actual costs and the preferable cost target if expect costs are $4 or $5 million. If the agent were offered these three contract options, then the $3 million cost target would be preferred if expected actual costs were below $3.5 million; the $4 million cost target would be preferred if expected actual costs were between $3.5 and $4.5 million; the $5 million cost target would be preferred if expected actual costs were above $4.5 million. Thus, if the

agent were offered a choice between these three contract structures, then the agent's choice reveals information regarding the agent's expected cost.[7]
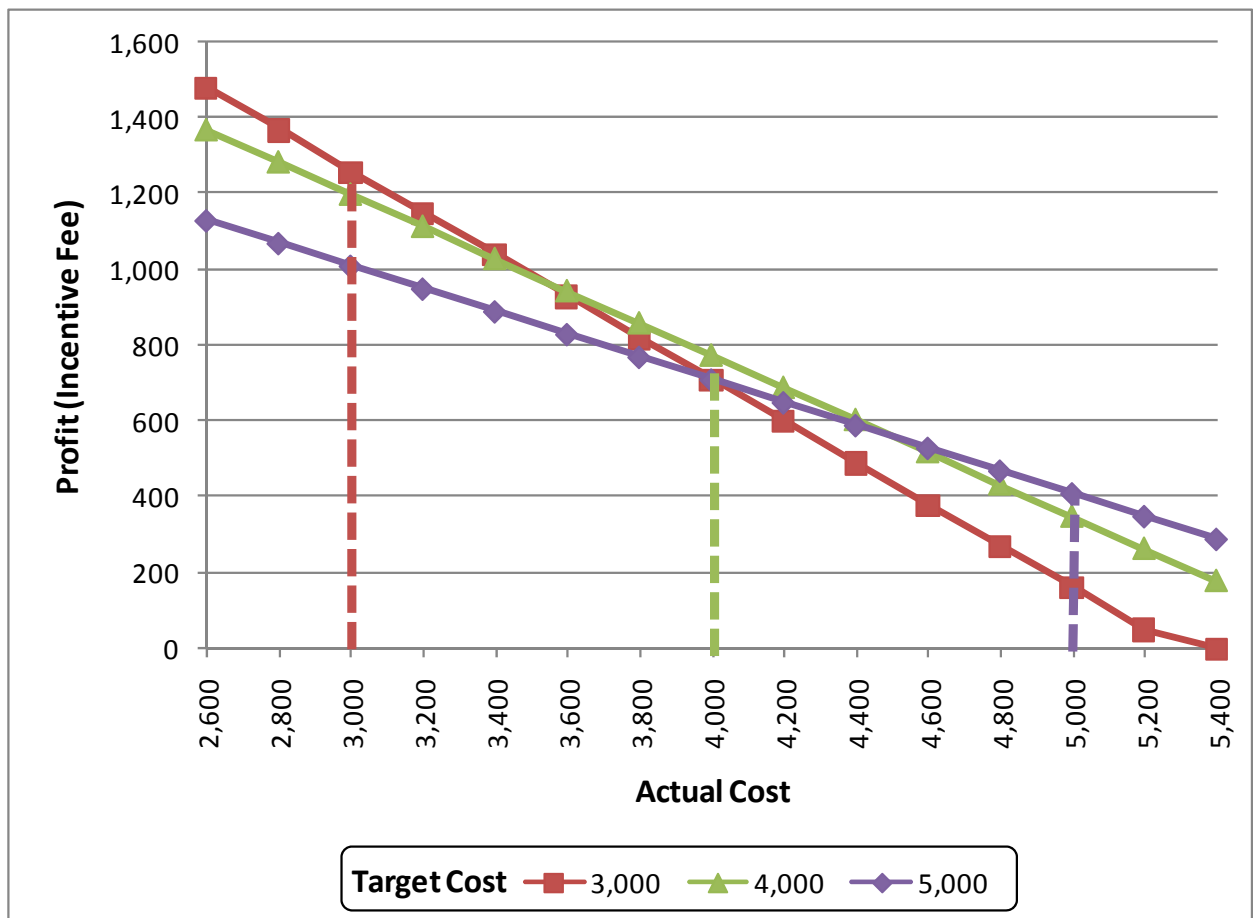
Figure 5.   TRIM Contract Structure

Table 2 below calculates the agent's profits as expected-actual costs vary for each of the TRIM contract options in Table 1. The agent's expected-actual costs are listed across the top row in Table 2. The values in each column show the agent's profits for the associated expected-actual cost under each of the contract options in Table 1; the contract options are represented by their target cost. An agent would prefer the contract option that offers the largest profits, given the agent's expected-actual costs. As illustrated in Table 2, the target cost for the preferred contract

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[7] With cost uncertainty and risk aversion, the expected cost in which the agent switches from one cost target to another would depend on the cost distribution and on the agent's risk preferences.

option is equal to the expected-actual costs for all costs depicted ion Table 2. This relationship will hold for any contract menu constructed as described above. The range of profits, and hence the truthful revelation properties, will increase as the feasible cost range and/or the cost-sharing ratio range increases.

Table 2 also illustrates that the TRIM CPIF contract structure maintains the same incentives for agent's to reduce actual costs once they have selected a contract option (represented by a target cost). The incentive fee decreases as actual cost increases in any given row of Table 2. Because the agent shares in any cost under-run or over-run, there is an incentive to reduce actual costs. As with any cost reimbursement contract, the agent's incentive to control actual costs increases with the cost-sharing ratio. The cost-savings incentive is highest under a fixed-price contract in which the agent bears the entire burden or any cost over-run and realizes the entire benefit of any cost under-run.

Table 2.   TRIM CPIF Agent Profits

Target Cost ($1000)	Actual Cost ($1,000)														
	2,600	2,800	3,000	3,200	3,400	3,600	3,800	4,000	4,200	4,400	4,600	4,800	5,000	5,200	5,400
2,600	**1,490**	1,370	1,250	1,130	1,010	890	770	650	530	410	290	170	50	0	0
2,800	1,488	**1,373**	1,258	1,143	1,028	913	798	683	568	453	338	223	108	0	0
3,000	1,480	1,370	**1,260**	1,150	1,040	930	820	710	600	490	380	270	160	50	0
3,200	1,468	1,363	1,258	**1,153**	1,048	943	838	733	628	523	418	313	208	103	0
3,400	1,450	1,350	1,250	1,150	**1,050**	950	850	750	650	550	450	350	250	150	50
3,600	1,428	1,333	1,238	1,143	1,048	**953**	858	763	668	573	478	383	288	193	98
3,800	1,400	1,310	1,220	1,130	1,040	950	**860**	770	680	590	500	410	320	230	140
4,000	1,368	1,283	1,198	1,113	1,028	943	858	**773**	688	603	518	433	348	263	178
4,200	1,330	1,250	1,170	1,090	1,010	930	850	770	**690**	610	530	450	370	290	210
4,400	1,288	1,213	1,138	1,063	988	913	838	763	688	**613**	538	463	388	313	238
4,600	1,240	1,170	1,100	1,030	960	890	820	750	680	610	**540**	470	400	330	260
4,800	1,188	1,123	1,058	993	928	863	798	733	668	603	538	**473**	408	343	278
5,000	1,130	1,070	1,010	950	890	830	770	710	650	590	530	470	**410**	350	290
5,200	1,068	1,013	958	903	848	793	738	683	628	573	518	463	408	**353**	298
5,400	1,000	950	900	850	800	750	700	650	600	550	500	450	400	350	**300**

To summarize, both the principal and agent can potentially gain by offering the contractor a choice of truth-revealing contracts. The agent receives higher profits by choosing the contract that most accurately reflects its expected costs. In the above example, a low-cost contractor receives higher profits with a lower cost target than it would if it accepted a higher cost target. Similarly, a high-cost

contractor receives higher profits with a higher cost target than it would if it accepted a lower cost target. Offering the properly structured choices ensures consistency between the cost target and expected costs. The principal gains by tailoring the contract incentives to the agent's true expected cost. The agent is induced to reveal its true expected cost by choosing from a menu of appropriately structured contracts. The agent still faces the same cost-savings incentives as in traditional cost reimbursement contracts.

C.   TRIM Benefits in DoD Contracting Applications

1.   More Accurate Cost Estimates

Because the TRIM is truth-revealing, the Government has better insight into the true costs of projects, or at least what the contractor believes to be their true costs. In traditional CPIF contracts, contractors have an incentive to overstate costs to increase their award fee pool, if the available budget allows. TRIM provides the Government with accurate cost estimates up front and saves either the time and/or money it takes to repeatedly return to the financial coffers for additional funding or the excessive costs of an overstated cost target.

2.   Bargaining/Negotiating Costs

The output of the TRIM is a contract menu from which a contractor chooses his preferred contract. Incentives are configured so the contractor earns a higher fee if they reveal the truth. With Government and contractor objectives aligned, the scenario becomes win-win and there is no need for long, drawn-out negotiations. Negotiations using the TRIM are short and save time.

3.   Information Costs

TRIM helps minimize information asymmetries during contract negotiation by aligning the DoD's and the contractor's incentives. When the contractor has an incentive to misstate their proposed costs, the Government must acquire information to better understand expected-actual costs. Acquiring cost and pricing information from contractors is costly. TRIM helps minimize the DoD's need to gather information about a program prior to contract award.

IV. Summary and Issues for Future Research

A. Summary

Principal-agent relationship problems exist in all contractual relationships—especially cost reimbursement contracts. Contractor opportunism, such as artificially inflating target costs in sole-source contracts and using the "B-Team" to execute a contract, are strategic behaviors that contractors can use to further their objectives at the Government's expense. Principal-agent problems contribute to the cost over-runs that plague DoD procurement.

This report derives a theoretical approach to address truthful cost revelation in sole-source contracts. It summarizes Pupich and Lewis' (2007) work to fit this theoretical structure into the the DoD contracting environment, creating a bridge from theory to application. This bridge is captured in Pupich and Lewis' TRIM user's manual, replicated here as Appendix B.

The theoretical mechanism did not account for the DoD's budget considerations. A budget constraint was added to the theoretical mechanism to alert a contracting officer when there are insufficient funds to award a contract. The theoretical mechanism created a profit pool range based on the economic concept of individual rationality. The minimum profit was selected to ensure the contractor would willingly enter into the contract; the maximum fee had no upper bounds since it was calculated from the feasible cost range and the cost-sharing ratios. The operational model adds a budget constraint and signals when the proposed contract parameters result in total costs exceeding the budget constraint. It adjusts the cost target range so that total costs satisfy the DoD's budget constraint while maintaining TRIM's truthful revelation properties.

The operational model also incorporates the DoD *Supplement to the Federal Acquisition Regulations* (*DFAR*) guidelines to determine a fair and reasonable fee. *DFAR* 215.404-4 mandates that negotiated cost reimbursement contracts use a

structured approach to set a fee that appropriately accounts for the contractor's risk given the proposed work. The operational model incorporates weighted guidelines to determine potential fees. Using the weighted guidelines should facilitate an appropriate fee calculation, reflecting historical profits for projects similar in complexity and size as captured by the DoD Form 1547. The weighted guidelines fee is associated with the most likely contract cost target (the mid-point of the cost target range).[8]

B. Issues for Future Research

1. Risk Aversion

TRIM can be used in negotiating sole-source, cost-plus-award fee/incentive fee (CPAF/IF) contracts to combat principal-agent problems by aligning contractor and Government objectives. Cost-reimbursement contracts are typically used when there are significant contract uncertainties, including development and design work. The government is generally considered more capable of bearing the risk of significant contract uncertainties; contractors would require substantial risk premiums to bear these risks *(FAR)*.

The analysis presented here assumed that agents (contractors) are risk-neutral. If contractors are risk-averse and cost-reimbursement contracts are used in situations with significant program risk, then it is important to explore the impact of risk aversion and its affect on TRIM contract selection. Risk aversion and the risk associated with a particular DoD program could affect the preferred cost-sharing ratios and may suggest asymmetries in the sharing ration for cost under- and over-runs.

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[8] For further discussion of these and other adaptations, see Pupich and Lewis (2007).

2.   Test and Implement the Mechanism

The next logical step in this research is to beta test the mechanism using experimental economics to replicate a mock negotiation situation. Experimental economics would allow the research to control the participants' incentives, isolate the impacts of the TRIM contract design and explore issues such as agent risk aversion. After completing the experiments and incorporating the resulting lessons learned, the next step is to pilot test TRIM in a low-dollar value and short period of performance-negotiated contract.

3.   Competitive Contracting Environments

The current proposed TRIM meets *FAR* policy guidelines for handling negotiated procurements in a sole-source environment. In a competitive procurement, TRIM would need to balance the truth-revelation properties inherent in the current model against the incentive to understate costs to increase the probability of winning the contract. The current TRIM model does not address competitive procurement. An operational mechanism design appropriate for a competitive procurement environment would significantly broaden TRIM's applicability.

In summary, TRIM appears to be an interesting approach to reducing the cost over-run problems persistent in DoD acquisitions. TRIM addresses principal-agent problems more effectively than the DoD's typical cost-reimbursement contract structure. Although in its infancy, TRIM is ready to move to experimental and pilot testing for negotiating and administering CPAF/IF contracts in a sole-source environment. Future research should develop TRIM alternatives that bolster the mechanism's fidelity and broaden its applicability, specifically for risk-averse agents in competitive procurement environments.

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Appendix A. Truth-revealing Incentive Mechanism Derivation

The contracting problem analyzed here can be described as follows. A principal wants to engage an agent to develop a unique product and supply one unit. There is only one potential agent. The agent is risk-neutral with respect to the outcome of this task (this could be satisfied for a risk-averse agent if the task was a small enough part of the agent's total business). Furthermore, the principal can perfectly monitor the agent's effort and *ex post* costs. However, the principal does not know the agent's costs *ex ante*, only the probability density function over costs. On the other hand, the agent does know costs *ex ante*. The agent's objective is to maximize profits; the principal's objective is to minimize costs. Finally, due to legal and institutional constraints, the principal must use a cost-plus-incentive-fee contract (CPIF). A CPIF contract reimburses the agent for all costs incurred and offers an additional award if the agent performs well: the better the agent's performance, the higher the award.

With perfect monitoring and risk neutrality, moral hazard and risk aversion are not problems in this relationship. The primary problem facing the principal is to structure the contract incentives to force the agent to reveal its true costs. If the principal knew the agent's costs *ex ante*, the cost-minimizing contract would pay the agent an amount equivalent to his total opportunity costs (actual costs plus the minimum acceptable level of profits). However, the principal does not know the agent's costs *ex ante*. Therefore, with a CPAF contract, the agent has an incentive to overstate expected costs to improve perceived performance and increase profits.

To counterbalance this incentive, the principal must offer the agent a reward for revealing actual costs. The size of the required reward depends on how valuable the information is to both the principal and the agent. If the agent has low costs, the information is valuable to both parties. Setting the target cost above actual costs increases both the principal's costs and the agent's profits; the reward for revealing

ex ante that costs are low must be relatively large. If costs are actually high, the information is less valuable to both parties reducing the required reward.

To formally describe the contracting problem, let:

$$C_o \quad = \text{Target Cost,}$$

$$C_a \quad = \text{Actual Cost,}$$

$f(C)$ = Principal's Prior Probability Distribution Function over C,

$F(C)$ = Principal's Cumulative Probability Distribution over C,

$A(C)$ = Total Available Award Fee as a Function of C, and

$\mu(C)$ = Cost-sharing Ratio as a Function of C.

The agent's profits, $\prod(C_o,C_a)$, will be a function of both the target and actual costs. In particular,

$$\prod(C_o,C_a) = A(C_o) + \mu(C_o)[C_o - C_a]. \tag{1}$$

The agent's objective is to select C_o so as to maximize $\prod(C_o,C_a)$.

Similarly, the principal's objective is to minimize costs. This is equivalent to minimizing the agent's profits because the principal can perfectly monitor *ex post* costs and the agent's effort (profits would be zero if the principal had perfect cost information *ex ante*). However, the agent must be willing to voluntarily participate in the relationship ($\prod(C) \geq 0$). This imposes one constraint on the principal's minimization problem. In addition, according to the revelation principal, the principal need only consider incentive structures that induce truthful cost revelation ($\prod^a(C_a,C_a) \geq \prod^o(C_o,C_a)$ for all C_a and C_o).[9] This imposes another constraint on the principal's minimization problem. Thus, the principal's objective is to minimize:

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[9] Baron and Myerson (1982) describe the revelation principal in some detail. Intuitively, for any contract that does not induce truthful revelation, a contract can be developed that does induce truthful revelation and has an identical outcome to the non-truth-revealing contract. Thus, any contract that does not induce truthful revelation can be replaced by an equivalent truth-revealing contract. Thus, in designing a contract, the principal need only consider truth-revealing contracts.

$$\int_C \{A(C_0) + \mu(C_0)(C_0 - C_a)\} f(C_a) dC_a,$$ (2)

subject to:

$$\prod\nolimits^a(C_a, C_a) = \max \prod\nolimits^o(C_o, C_a) \text{ for all C; and}$$ (3)

$$\prod(C) \geq 0.$$ (4)

It is possible to show that a contract will satisfy the requirements of truthful revelation and voluntary participation if and only if the following three conditions are satisfied:

$$\mu(C_o) \leq \mu(C_a) \text{ for } C_o > C_a;$$ (5)

$$A(C) = A(C_1) + \int_C^{C_1} \mu(C^*) dC^*, \text{ and}$$ (6)

$$\prod(C_1) \geq 0, \text{ where } C_1 \text{ is the highest potential value of C.}$$ (7)

<u>Proof:</u> First, it is necessary to show that (3) and (4) directly imply (5), (6), and (7). (7) follows directly from (4), leaving only the derivation of (5) and (6). To see (5), consider two possible cost reports C_a and C_o. Truthful revelation, as implied by (3), requires that the agent report C_a if that is the true cost and C_o if that is the true cost. If C_a is the true cost, then from (3), $\prod^a(C_a, C_a) \geq \prod^o(C_o, C_a)$. Plugging the definition for profits (1) into this expression yields:

$$A(C_a) \geq A(C_o) + \mu(C_o)[C_o - C_a].$$

This can be rewritten as:

$$A(C_a) - A(C_o) \geq \mu(C_o)[C_o - C_a].$$

If C_o is the true cost, then from (3), $\prod^o(C_o,C_o) \geq \prod^a(C_a,C_o)$. Plugging the definition for profits (1) into this expression yields:

$$A(C_o) \geq A(C_a) + \mu(C_a)[C_a - C_o].$$

This can be rewritten as:

$$A(C_a) - A(C_o) \leq \mu(C_a)[C_o - C_a].$$

Combining these two expressions yields:

$$\mu(C_o)[C_o - C_a] \leq A(C_a) - A(C_o) \leq \mu(C_a)[C_o - C_a]. \tag{8}$$

This implies (5), $\mu(C_o) \leq \mu(C_a)$ for $C_o \geq C_a$. In other words, the cost-sharing ratio must decrease as the target cost increases.

To derive (6), divide (8) by $(C_a - C_o)$ and take the limit as $C_o \longrightarrow C_a$. Using L'Hôpital's Rule, truthful revelation would imply that $-B(C_a) \leq A'(C_a) \leq -B(C_a)$. This can only hold if

$$A'(C_a) = -B(C_a). \tag{9}$$

In other words, if the target cost increases, the total available award fee should be reduced by an amount equivalent to the cost-sharing ratio. Integrating both sides of equation (9) yields:

$$\int_{C_a}^{C_1} A'(C^*)dC^* = -\int_{C_a}^{C_1} \mu(C^*)dC^*.$$ This can be rewritten as:

$$-\int_{C_1}^{C_a} A'(C^*)dC^* = -\int_{C_a}^{C_1} \mu(C^*)dC^*.$$ Solving the integral on the left and rewriting

implies (6),

$$A(C_a) = A(C_1) + \int_{C_a}^{C_1} \mu(C^*)dC^*.$$

It is also necessary to show that (5), (6), and (7) directly imply (3) and (4). (4) follows directly from (6) and (7) because $\prod(C_1) = A(C_1)$ under truthful revelation and $\mu(C)$ is always positive. (3) can be derived as follows. From (6), $A(C_0)$ can be expressed as:

$$A(C_0) = A(C_1) + \int_{C_0}^{C_1} \mu(C^*)dC^*.$$

This is equivalent to $A(C_a)$ except for the limits of integration. Thus, $A(C_0)$ can be rewritten as:

$$A(C_0) = A(C_a) - \int_{Ca}^{C_0} \mu(C^*)dC^*. \tag{10}$$

Recall also from (1), that:

$$\prod(C_0, C_a) = A(C_0) + \mu(C_0)[C_0 - C_a].$$

This can be rewritten as:

$$\prod(C_0, C_a) = A(C_0) + \int_{Ca}^{C_0} \mu(C_0)dC_0.$$

Substituting (10) into this expression yields:

$$\prod(C_0, C_a) = A(C_a) - \int_{Ca}^{C_0} [\mu(C^*) - \mu(C_0)]dC^*, where\ A(C_a) = \prod(C_a, C_a). \tag{11}$$

(3) follows directly from this expression. When $C_0 > C_a$ (which implies $C_0 > C^*$), then $\mu(C^*) > \mu(C_0)$ by (5). Therefore, the integrand in (11) is non-negative, which

implies $\prod(C_o, C_a) \leq \prod(C_a, C_a)$. Conversely, when $C_o < C_a$, then the integrand is non-positive. However, the integral is non-negative because the direction of integration is reversed. Therefore, $\prod(C_o, C_a) \leq \prod(C_a, C_a)$ still holds in this case. Thus, (3) and (4) are implied by (5), (6), and (7).

If the incentive contract has the properties implied by (5), (6), and (7), then the agent will voluntarily participate and truthfully report expected costs. With truthful revelation, the principal's cost minimization problem as stated in (2) can be reformulated as minimizing

$$\int_C A(C_a) f(C_a) dC_a \, ,$$

subject to:

$$\prod(C_1) = A(C_1) \geq 0.$$

By plugging in (6), this can be rewritten as:

$$\int_C \left\{ A(C_1) + \int_C^{C_1} \mu(C^*) dC^* \right\} f(C_a) dC_a \, .$$

This simplifies to:

$$A(C_1) + \int_C \mu(C^*) F(C^*) dC^* \, .$$

To minimize this expression while retaining voluntary participation requires that $A(C_1) = 0$.

A and μ can take several possible forms and still satisfy the conditions specified here. Two possibilities are:

1. $A = (C_1 - C_a)/S$ and $\mu = 1/S$, where S is any scalar.
2. $A = e^{S(C_1 - C_a)} - 1$ and $\mu = S e^{S(C_1 - C_a)}$.

Appendix B.   The TRIM User's Guide[10]

A.   Purpose

This user's guide introduces Government-contracting professionals to the Truth-revealing Incentive Mechanism (TRIM) and explains how the TRIM can be used in negotiating and administering cost-plus-award-fee/incentive-fee (CPAF/IF) contracts.

The TRIM is an economic mechanism, based on principal-agent relationships, that uses incentives to align contractors' interests with those of the Government. The TRIM was designed for cost-reimbursement contracts. Specifically, the TRIM is intended for CPAF/IF contracts. The mechanism is called "truth revealing" because it structures incentives so the contractor will select a contract option that most closely reflects their actual expected cost. In other words, the incentive structure ensures the contractor maximizes expected fees by choosing a low-cost target if expected costs are low and by choosing a high-cost target if expected costs are high.

The user's guide is broken down into three sections. The first section gives a step-by-step explanation on how to use the TRIM. The second provides a fee pay-out table to explain how the TRIM incentivizes contractors to reveal their true costs. The third explains how to administer the fee on a CPAF/IF contract using the TRIM.

B.   How TRIM Incentivizes Contractors to Truthfully Reveal Costs

Simply put, the TRIM generates a variety of contract options from which a contractor can choose. The options provided by the TRIM read like a restaurant menu. Each option on the menu has three components listed in the columns: target cost, share ratio, and target fee. Each row on the menu is a contract option available to the contractor. Each row is a packaged deal—the contractor cannot

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[10] This User's Guide is adapted in its entirety from Pupich and Lewis (2008, December), Appendix A.

select a target cost from one row and a share ratio or target fee from another. Table 3 is an example of a contract menu established by the TRIM. The highlighted row signifies one of the many options available.

Table 3.   TRIM-based Contract Menu

Contract Menu		
Target Cost	**Share Ratio**	**Target Fee**
$31,500	0.600	$5,906
$32,000	0.568	$5,614
$32,500	0.536	$5,338
$33,000	0.504	$5,079
$33,500	0.471	$4,835
$34,000	0.439	$4,607
$34,500	0.407	$4,396
$35,000	0.375	$4,200
$35,500	0.343	$4,021
$36,000	0.311	$3,857
$36,500	0.279	$3,710
$37,000	0.246	$3,579
$37,500	0.214	$3,463
$38,000	0.182	$3,364
$38,500	0.150	$3,281

Incentives are structured so the contractor has the potential to earn the highest fee if he/she chooses the contract closest to their actual expected costs. The TRIM is truth revealing because of the relationship set-up between the target cost, share ratio, and the target fee. As the cost target increases, the sharing ratio and the target fee decrease.

Here are a few examples of how the TRIM helps reveal the truth from a contractor trying to "game" the system. Many cost-reimbursement contracts establish their target fee as a percentage of target cost. By establishing target fee

as a percentage of cost, a contractor is incentivized to inflate target costs as high as possible to gain a larger target fee and reduce risk. This type of gamesmanship is common in sole-source environments where competitive market forces are absent. The TRIM combats this strategy by structuring incentives so that choosing a higher target cost leads to a lower target fee. The TRIM also decreases the contractor share ratio as target costs increase so that the under-run incentive becomes less enticing.

Another example of contractors trying to game the system is when a contractor "buys-in" to increase their chance of winning a contract. A contractor buys-in on a contract when they propose a target cost lower than their estimated true cost. At first glance, Table 3 gives the impression that it's lucrative for a contractor to buy-in: the target fee increases as the target cost decreases. However, in this case, it is the share ratio's function of the mechanism that incentivizes the contractor to reveal true cost. The lower the target cost, the higher the share ratio. A higher share ratio creates a stronger incentive for not exceeding target cost. As a result of buying-in, the contractor is bound by the chosen option's share ratio that decreases the resulting fee at a rate faster than the contractor's estimated true cost option not chosen. Again, through the use of the TRIM, the contractor is incentivized to reveal their true costs to potentially receive the highest fee.

The remainder of this appendix will give step-by-step instructions on entering inputs into the TRIM so a menu of contracts can be developed for the contractor.

1.   Target Cost

The target cost is the first item to enter into the TRIM. The target cost is synonymous with most-likely cost. The Government should determine the most-likely cost by taking the following cost estimates and information into consideration: market research data, historical cost data, the selected contractor's proposed target cost, independent Government cost estimate, and the proposed target costs of other contractors in the competitive range.

When considering the above mentioned cost estimates, it is important to make an "apples-to-apples" comparison by identifying the factors affecting comparability (scope, assumptions, terms and conditions, etc.), determining the effects of those factors, and adjusting each cost estimate by taking these factors into consideration. Cost data should already be normalized during the source selection when comparing proposals in choosing the best-value contractor. Using the normalized cost estimates, the average target cost value is entered into the target cost cell of the TRIM. Figure 6 gives an example of $35,000 being entered as the target cost.

TRUTH-REVEALING INCENTIVE MECHANISM

		Cost Target	Share Ratio	Profit Pool		Cost Total	Profit % of Proposed Cost Target	Profit % of Chosen Cost Target
Contractor Proposed Target Cost	$ 35,000.00	$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
Cost Target Bounds (%)		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
Target Fee		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
Max Share Ratio		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
Min Share Ratio		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
Target Cost	$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
Budget	##########							

Figure 6.   Target Cost Input

After entering the target cost into the TRIM, every target cost option available on the menu of contracts will be the same. This will change; all the target costs on the contract menu will be the same until the target cost range is entered. Only the target cost value on the menu, highlighted above, will remain the same.

2.   Target Cost Range

Target cost range is the second input to enter into the TRIM. Since the target cost estimate entered in step 1 is only a point estimate, it is likely there will be variation between the target cost and actual cost. Consequently, a variance percentage must be entered into the TRIM to account for cost variability. For example, if actual costs are expected to fall somewhere within ±10% of the target cost, then 10% should be entered into the target cost range (shaded in Figure 7). This changes the values in the target cost column of the contract menu, allowing the selected contractor to choose a contract that falls within ±10% of the chosen target cost. Figure 7 shows how the 10% cost target range affects target costs on the contracts menu.

TRUTH-REVEALING INCENTIVE MECHANISM

		Cost Target	Share Ratio	Profit Pool		Cost Total	Profit % of Proposed Cost Target	Profit % of Chosen Cost Target
Contractor Proposed Target Cost	$ 35,000.00	$31,500	0.000	$	-	$ 31,500	0.0%	0.0%
Cost Target Bounds (%)	10%	$32,000	0.000	$	-	$ 32,000	0.0%	0.0%
		$32,500	0.000	$	-	$ 32,500	0.0%	0.0%
Target Fee		$33,000	0.000	$	-	$ 33,000	0.0%	0.0%
Max Share Ratio		$33,500	0.000	$	-	$ 33,500	0.0%	0.0%
Min Share Ratio		$34,000	0.000	$	-	$ 34,000	0.0%	0.0%
		$34,500	0.000	$	-	$ 34,500	0.0%	0.0%
Target Cost		$35,000	0.000	$	-	$ 35,000	0.0%	0.0%
		$35,500	0.000	$	-	$ 35,500	0.0%	0.0%
		$36,000	0.000	$	-	$ 36,000	0.0%	0.0%
		$36,500	0.000	$	-	$ 36,500	0.0%	0.0%
		$37,000	0.000	$	-	$ 37,000	0.0%	0.0%
		$37,500	0.000	$	-	$ 37,500	0.0%	0.0%
		$38,000	0.000	$	-	$ 38,000	0.0%	0.0%
Target + 10%		$38,500	0.000	$	-	$ 38,500	0.0%	0.0%
Budget	##########							

Target - 10% → $31,500

Figure 7.   Target Cost Range Input

The original target cost ($35,000) placed in the middle of the contract menu acts as an anchor. On the menu, the target cost options located above the original target cost decrease linearly until reaching 10% below the original target cost. Similarly, the target cost options located below the original target cost increase linearly until reaching 10% above your original target cost.

When determining the percentage to use for the target cost range, risk of current market conditions and performance risk of the contractor should be considered. Performance risks can include but are not limited to type and complexity of item/service being purchased, contractor past performance in similar efforts, availability of historical data, urgency of the requirement, technical maturity of the system, and extent and nature of subcontracting (DPAP, 2008).

3.   Target Fee

The third column in the contracts menu is the target fee. The target fee is the "potential" fee a contractor will earn if schedule and performance requirements are met at target cost. Similar to how a single target cost was used to fill an entire menu of target cost options in step 1, a single target fee value is used to determine an entire menu of target fee options for the contractor. The single target fee value is a percentage of the target cost determined in step 1. In determining a fair and reasonable target fee percentage, guidance from the *Federal Acquisition Regulation* was sought.

The *Federal Acquisitions Regulation* (*FAR* 15.404-4 Profit) mandates that each agency use a structured approach when determining profit or fee for negotiated acquisitions that require cost analysis. The Department of Defense has their own structured approach, the weighted guidelines method for determining fair and reasonable fee. Instructions for using the weighted guidelines method can be found in the *Department of Defense Federal Acquisition Regulation Supplement* (*DFARS* 215.40470). This *DFARS* instruction guides the user in how to fill out the DD Form 1574, Record of Weighted Guidelines Application. Completing DD Form 1574 calculates a fair and reasonable fee percentage to enter into the TRIM (shaded in Figure 8). Since the TRIM is used in CPIF contracts, weighted guidelines are not mandatory. The weighted guidelines should only be used as a starting point to find a fair and reasonable range for target fees. The range of fees used in past CPAF contracts for similar efforts also provides a point of comparison.

TRUTH-REVEALING INCENTIVE MECHANISM

		Cost Target	Share Ratio	Profit Pool	Cost Total	Profit % of Proposed Cost Target	Profit % of Chosen Cost Target
Contractor Proposed Target Cost	$ 35,000.00	$31,500	0.000	$4,200.00	$ 35,700	12.0%	13.3%
Cost Target Bounds (%)	10%	$32,000	0.000	$4,200.00	$ 36,200	12.0%	13.1%
		$32,500	0.000	$4,200.00	$ 36,700	12.0%	12.9%
Target Fee	12%	$33,000	0.000	$4,200.00	$ 37,200	12.0%	12.7%
Max Share Ratio		$33,500	0.000	$4,200.00	$ 37,700	12.0%	12.5%
Min Share Ratio		$34,000	0.000	$4,200.00	$ 38,200	12.0%	12.4%
		$34,500	0.000	$4,200.00	$ 38,700	12.0%	12.2%
Target Cost		$35,000	0.000	$4,200.00	$ 39,200	12.0%	12.0%
		$35,500	0.000	$4,200.00	$ 39,700	12.0%	11.8%
		$36,000	0.000	$4,200.00	$ 40,200	12.0%	11.7%
		$36,500	0.000	$4,200.00	$ 40,700	12.0%	11.5%
		$37,000	0.000	$4,200.00	$ 41,200	12.0%	11.4%
		$37,500	0.000	$4,200.00	$ 41,700	12.0%	11.2%
		$38,000	0.000	$4,200.00	$ 42,200	12.0%	11.1%
		$38,500	0.000	$4,200.00	$ 42,700	12.0%	10.9%
Budget	##########						

Figure 8.   Target Fee Input

Once the target fee percentage has been entered, the TRIM automatically multiplies the target fee percentage by the target cost to determine the dollar value for the profit pool. In Figure 8, every profit pool option available on the menu of contracts is the same. All profit pool values on the contract menu will be the same until the share ratios are entered in the next two steps. The only profit pool option remaining the same will be the middle target fee value on the menu, highlighted in Figure 8. Once minimum and maximum share ratios are entered, TRIM will calculate the fee options based on the original target fee, target cost options, and share ratios.

4.   Maximum Share Ratio

In the context of using the TRIM, sharing ratio is defined as the percentage of risk assumed by the contractor. For example, if the sharing ratio is 60%, then the contractor assumes 60% of the risk when the target cost deviates from the actual cost. If the contractor performed well, causing the actual cost to be lower than the target cost, then the contractor earns 60 cents of every dollar under the target cost. Conversely, if the contractor performed poorly, causing actual cost to be higher than

the target cost, 60 cents of every dollar over the chosen target cost is deducted from the target fee. The maximum share ratio should be determined by considering the upper limit of risk that a prudent contractor would be willing to accept on this particular contract, given current market conditions. A point to consider, the closer the contractor's share ratio approaches 100%, the closer the contract mimics a firm fixed-price arrangement. Figure 9 shows how a maximum share ratio of 60% (highlighted in yellow) populates the share ratio column as well as alters the profit-pool column of the contract menu. Until a minimum share ratio is entered, the TRIM assumes the minimum share ratio is zero and populates the share ratio column linearly from 60% down to a 0% share ratio.

TRUTH-REVEALING INCENTIVE MECHANISM

		Cost Target	Share Ratio	Profit Pool	Cost Total	Profit % of Proposed Cost Target	Profit % of Chosen Cost Target
Contractor Proposed Target Cost	$ 35,000.00	$31,500	0.600	$5,775.00	$ 37,275	16.5%	18.3%
Cost Target Bounds (%)	10%	$32,000	0.557	$5,485.71	$ 37,486	15.7%	17.1%
		$32,500	0.514	$5,217.86	$ 37,718	14.9%	16.1%
Target Fee	12%	$33,000	0.471	$4,971.43	$ 37,971	14.2%	15.1%
Max Share Ratio	0.6	$33,500	0.429	$4,746.43	$ 38,246	13.6%	14.2%
Min Share Ratio		$34,000	0.386	$4,542.86	$ 38,543	13.0%	13.4%
		$34,500	0.343	$4,360.71	$ 38,861	12.5%	12.6%
Target Cost	$35,000	0.300	$4,200.00	$ 39,200	12.0%	12.0%
		$35,500	0.257	$4,060.71	$ 39,561	11.6%	11.4%
		$36,000	0.214	$3,942.86	$ 39,943	11.3%	11.0%
		$36,500	0.171	$3,846.43	$ 40,346	11.0%	10.5%
		$37,000	0.129	$3,771.43	$ 40,771	10.8%	10.2%
		$37,500	0.086	$3,717.86	$ 41,218	10.6%	9.9%
		$38,000	0.043	$3,685.71	$ 41,686	10.5%	9.7%
		$38,500	0.000	$3,675.00	$ 42,175	10.5%	9.5%
Budget	##########						

Figure 9.   Maximum Share Ratio Input

5. Minimum Share Ratio

In the context of using the TRIM, the sharing ratio is defined as the percentage of risk assumed by the contractor. For example, if the sharing ratio was 15%, then the contractor assumes 15% of the risk the target cost will deviate from the actual cost of the contract. If the contractor performs well, resulting in an actual cost lower than the target cost, then the contractor earns 15 cents of every dollar of the under-run. Conversely, if the contractor performs poorly, causing the actual cost to be higher than the target cost, then 15 cents of every dollar over the chosen target cost is deducted from the target fee. Since share-ratio risk is shifted between the contractor and the Government, the minimum share ratio should consider the maximum amount of risk the Government is willing to accept on this particular contract given current market conditions. For example, if the Government is willing to bear a maximum of 85% of the risk, then the minimum contractor risk should be set at 15%. Another point to consider, as the contractor's share ratio approaches zero, the contract mimics a cost-plus-fixed-fee (CPFF) arrangement. Figure 10 shows how a minimum share ratio of 15% (highlighted) populates the share ratio column as well as alters the profit pool column of the contract menu. After the minimum share ratio is entered, the profit pool column will adjust to the minimum share ratio.

TRUTH-REVEALING INCENTIVE MECHANISM

	Cost Target	Share Ratio	Profit Pool	Cost Total	Profit % of Proposed Cost Target	Profit % of Chosen Cost Target
Contractor Proposed Target Cost $ 35,000.00	$31,500	0.600	$5,906.25	$ 37,406	16.9%	18.8%
Cost Target Bounds (%) 10%	$32,000	0.568	$5,614.29	$ 37,614	16.0%	17.5%
	$32,500	0.536	$5,338.39	$ 37,838	15.3%	16.4%
Target Fee 12%	$33,000	0.504	$5,078.57	$ 38,079	14.5%	15.4%
Max Share Ratio 0.6	$33,500	0.471	$4,834.82	$ 38,335	13.8%	14.4%
Min Share Ratio 0.15	$34,000	0.439	$4,607.14	$ 38,607	13.2%	13.6%
	$34,500	0.407	$4,395.54	$ 38,896	12.6%	12.7%
Target Cost	$35,000	0.375	$4,200.00	$ 39,200	12.0%	12.0%
	$35,500	0.343	$4,020.54	$ 39,521	11.5%	11.3%
	$36,000	0.311	$3,857.14	$ 39,857	11.0%	10.7%
	$36,500	0.279	$3,709.82	$ 40,210	10.6%	10.2%
	$37,000	0.246	$3,578.57	$ 40,579	10.2%	9.7%
	$37,500	0.214	$3,463.39	$ 40,963	9.9%	9.2%
	$38,000	0.182	$3,364.29	$ 41,364	9.6%	8.9%
	$38,500	0.150	$3,281.25	$ 41,781	9.4%	8.5%

Budget ##########

Figure 10.   Minimum Share Ratio Input

6.   Budget

The final input into the TRIM is budget. The budget is the dollar amount, authorized by Congress, to be expended on this particular procurement. The budget should include both cost and fee. Figure 11 provides guidance for entering the budget. In Figure 11, the budget cell is located in the bottom left corner, highlighted in yellow. Currently, there is a large placeholder value in the budget cell. The large placeholder ensures the contract menu is not constrained by the budget.

TRUTH-REVEALING INCENTIVE MECHANISM

		Cost Target	Share Ratio	Profit Pool	Cost Total	Profit % of Proposed Cost Target	Profit % of Chosen Cost Target
Contractor Proposed Target Cost	$ 35,000.00	$31,500	0.600	$5,906.25	$ 37,406	16.9%	18.8%
Cost Target Bounds (%)	10%	$32,000	0.568	$5,614.29	$ 37,614	16.0%	17.5%
		$32,500	0.536	$5,338.39	$ 37,838	15.3%	16.4%
Target Fee	12%	$33,000	0.504	$5,078.57	$ 38,079	14.5%	15.4%
Max Share Ratio	0.6	$33,500	0.471	$4,834.82	$ 38,335	13.8%	14.4%
Min Share Ratio	0.15	$34,000	0.439	$4,607.14	$ 38,607	13.2%	13.6%
		$34,500	0.407	$4,395.54	$ 38,896	12.6%	12.7%
Target Cost		$35,000	0.375	$4,200.00	$ 39,200	12.0%	12.0%
		$35,500	0.343	$4,020.54	$ 39,521	11.5%	11.3%
Minimum budget needed for sufficient funds		$36,000	0.311	$3,857.14	$ 39,857	11.0%	10.7%
		$36,500	0.279	$3,709.82	$ 40,210	10.6%	10.2%
		$37,000	0.246	$3,578.57	$ 40,579	10.2%	9.7%
		$37,500	0.214	$3,463.39	$ 40,963	9.9%	9.2%
		$38,000	0.182	$3,364.29	$ 41,364	9.6%	8.9%
		$38,500	0.150	$3,281.25	$ 41,781	9.4%	8.5%
Budget	$60,000.00						

Minimum budget needed for unconstrained cost

Figure 11. Budget Input and Budget Constraints

There are also two important budget numbers shaded in Figure 11, in the cost-total column. The dollar values in the cost total column are the sum of the target cost and target fee in that particular row. The first important budget number ($39,200) represents the minimum budget required for the contract to have sufficient funds at the target cost. This dollar value is based on the most likely target cost estimate ($35,000) and the target fee established using a structured approach ($4,200). If the appropriated funding is less than this value, then there is not enough money to award a contract. If a budget value less than this number is entered, the TRIM mechanism will not work and an "insufficient funds" warning will result.

The second number highlighted in the cost total column in Figure 11 ($41,781) represents the minimum budget needed for the TRIM to operate without constraints. This number ($41,781) represents the budget needed to fully fund the contract to cover both the target cost at the highest point on the total cost range ($38,500) and the associated target fee ($3,281). Any dollar value less than this number will constrain the TRIM's ability to offer a contract option at the highest point on the total cost range (+10). If the budget is low enough to constrain the TRIM, a

"budget constrained" warning will result. Under a constrained budget, the upper bound of the target cost range is adjusted to the constrained budget and does not include the full target cost range that would be included without the budget constraint. While the effectiveness of the TRIM is not reduced, the Government budget boundaries clearly limit the contract option choices available to the contractor and weaken the incentives for truth revelation. The option desired by the contractor whose expected costs exceed the target cost may not be available if the budget is constrained. The notification of "budget constrained" reveals a restricted Government position in offering contract options with a higher target if their expected costs exceed the total budget. Simply put, the Government's financial boundaries are binding when a budget-constrained situation occurs.

C. Understanding the Fee Payout Table: How TRIM Incentivizes Contractors to Truthfully Reveal Costs

1. Offering the Contract Menu to Contractors

Once all inputs are entered into the TRIM, the contracts menu is ready for use in negotiations with the contractor. Table 4, which reproduces Table 3, is a snapshot of what the contract menu would look like given the input values in the previous section.

Table 4.   TRIM-based Contract Menu (Reproduced)

	Contract Menu		
Option	Target Cost	Share Ratio	Target Fee
1	$31,500	0.600	$5,906
2	$32,000	0.568	$5,614
3	$32,500	0.536	$5,338
4	$33,000	0.504	$5,079
5	$33,500	0.471	$4,835
6	$34,000	0.439	$4,607
7	$34,500	0.407	$4,396
8	$35,000	0.375	$4,200
9	$35,500	0.343	$4,021
10	$36,000	0.311	$3,857
11	$36,500	0.279	$3,710
12	$37,000	0.246	$3,579
13	$37,500	0.214	$3,463
14	$38,000	0.182	$3,364
15	$38,500	0.150	$3,281

There are several ways in which the contract menu can be used in negotiations with the contractor. The easiest way to negotiate a contract price is to hand the contracts menu over and let the contractor choose a contract option.

Alternatively, one can choose not to show the contractor the contract menu and instead, start negotiating by proposing the target cost option on the menu. If the contractor is satisfied with the target cost option, try to incentivize them by offering a larger target fee if they can lower their target cost. For example, if the contractor proposes a target cost of $36,000, based on the contract menu in Table 4, offer contractor option #10 ($36,000, 0.311, $3,857). If the contractor agrees to this price, then continue to offer a higher fee for a lower target cost (options #9, #8, #7, etc.) until the contractor no longer lowers their target cost.

On the other hand, if the contractor rejects the original offer, propose another contract option more aligned with their desires. For example, if the contractor proposes a target cost of $35,000, based on the contract menu above in Table 4, one could respond with option #8 ($35,000, 0.375, $4,200). If the contractor is unsatisfied with the counteroffer because they want a larger target fee ($4,600 is ideal for the contractor), then offer the contractor option #6 from the contract menu.

The negotiation should continue until the contract option that best aligns the Government's desires (lower cost) with the contractor's desires (higher fee) is found. Once again, it is important to require that the contractor choose across a row (i.e., they cannot choose the target cost from option #8, a share ratio from option #10, and a target fee from option #4. The contract menu is only truth revealing when the contractor chooses options as they are listed across the row.

2. The Fee Payout Table

The fee payout table is a tool to help understand that the TRIM is truth revealing. Table 5 is a snapshot of the fee payout table based on the example developed throughout the user's guide.

Table 5. TRIM-based Fee Payout Table

Target Cost ($1000) \ A	B 31,500	C 32,000	D 32,500	E 33,000	F 33,500	G 34,000	H 34,500	I 35,000	J 35,500	K 36,000	L 36,500	M 37,000	N 37,500	O 38,000	P 38,500
						Actual Cost ($1,000)									
31,500	**5,906**	5,606	5,306	5,006	4,706	4,406	4,106	3,806	3,506	3,206	2,906	2,606	2,306	2,006	1,706
32,000	5,898	**5,614**	5,330	5,046	4,763	4,479	4,195	3,911	3,627	3,343	3,059	2,775	2,491	2,207	1,923
32,500	5,874	5,606	**5,338**	5,071	4,803	4,535	4,267	3,999	3,731	3,463	3,196	2,928	2,660	2,392	2,124
33,000	5,834	5,582	5,330	**5,079**	4,827	4,575	4,323	4,071	3,820	3,568	3,316	3,064	2,813	2,561	2,309
33,500	5,778	5,542	5,306	5,071	**4,835**	4,599	4,363	4,128	3,892	3,656	3,421	3,185	2,949	2,713	2,478
34,000	5,705	5,486	5,266	5,046	4,827	**4,607**	4,388	4,168	3,948	3,729	3,509	3,289	3,070	2,850	2,630
34,500	5,617	5,413	5,210	5,006	4,803	4,599	**4,396**	4,192	3,988	3,785	3,581	3,378	3,174	2,971	2,767
35,000	5,513	5,325	5,138	4,950	4,763	4,575	4,388	**4,200**	4,013	3,825	3,638	3,450	3,263	3,075	2,888
35,500	5,392	5,221	5,049	4,878	4,706	4,535	4,363	4,192	**4,021**	3,849	3,678	3,506	3,335	3,163	2,992
36,000	5,255	5,100	4,945	4,789	4,634	4,479	4,323	4,168	4,013	**3,857**	3,702	3,546	3,391	3,236	3,080
36,500	5,103	4,963	4,824	4,685	4,546	4,406	4,267	4,128	3,988	3,849	**3,710**	3,571	3,431	3,292	3,153
37,000	4,934	4,811	4,688	4,564	4,441	4,318	4,195	4,071	3,948	3,825	3,702	**3,579**	3,455	3,332	3,209
37,500	4,749	4,642	4,535	4,428	4,321	4,213	4,106	3,999	3,892	3,785	3,678	3,571	**3,463**	3,356	3,249
38,000	4,548	4,457	4,366	4,275	4,184	4,093	4,002	3,911	3,820	3,729	3,638	3,546	3,455	**3,364**	3,273
38,500	4,331	4,256	4,181	4,106	4,031	3,956	3,881	3,806	3,731	3,656	3,581	3,506	3,431	3,356	**3,281**

In Table 5, the letters (A-P) represent the columns, and the numbers (1-16) represent the rows. The letters and numbers will be used to identify specific cells in explaining this payout table. The values in column A represent the target cost options available on the contract menu. The values in row 1 represent the actual contract cost. The values in cells B2 to P16 represent the potential fees available to the contractor given the respective target cost in column A and actual cost in row 1. The cells shaded in light blue (the diagonal cells in the range B2 to P16) highlight the highest potential fee a contractor can receive for a given actual cost.

The target fee function is structured such that contractors have the potential to receive a higher fee if they choose a lower target cost. This incentivizes the contractor to choose the lowest target cost possible, so long as their estimated actual costs are equal to or near the target cost. However, if the contractor knows their estimated costs are lower than the target cost, then the share ratios are structured so that contractors receive a lower fee by overstating the target cost and under-running the target than they would by simply accepting a lower cost target. At the same time, the share ratio incentivizes the contractor to save costs wherever possible, once the target cost has been selected, to generate a larger fee from an under-run. The mathematical relationship between the target fees, target costs, and share ratio ensure the additional fee gained from the under-run share ratio are lower than the increase in target fee from selecting a lower target cost. Reciprocally, the

fee lost from sharing the cost of over-running the target are always more than the increased target fee from selecting a lower target cost.

If a contractor could estimate with certainty that their true costs will be $34,000 (column G), the contractor earns the highest fee if they choose a target cost of $34,000 (cell G7). Cell G7 is highlighted in blue on the payout table because it is the highest fee the contractor can receive for an actual cost of $34,000. If the contractor estimates that their true costs will be $34,000 but decides to choose a different target cost, then the fee is not maximized. For example, suppose a contractor with expected costs of $34,000 acts strategically by choosing a higher target cost (e.g., $36,000) so they can earn additional fees from an under-run. The fee received in this scenario ($ 4,479, cell G11) is less than the fee received if the contractor revealed their true cost ($4,607, cell G7). On the other hand, if the contractor with expected costs of $34,000 acts strategically by choosing a lower target cost (e.g., $32,000) because the target fee is larger ($5,614), then the over-run share ratio will deplete the target fee so it is less ($4,479, cell G3) than the fee received if the contractor revealed their true cost ($4,607, cell G7).

D.   Administering a CPAF/IF Contract Fee Using TRIM

Before using the TRIM to administer fees during contract execution, it is important to understand the types of contracts that fit within the TRIM parameters. The TRIM is designed for cost reimbursement contracts. Specifically, the TRIM is intended for Cost-plus-award-fee/Cost-plus-incentive-fee (CPAF/IF) contracts. The following section explains how to use the TRIM contract menu and payout table to calculate the fee awarded to the contractor during CPAF/IF contract performance.

1.   Determining the Target Fee

The contractor selects their own target fee when they choose a contract option from the contract menu. Once the contractor has chosen their target fee, it is time to use the TRIM to divide the target fee between an incentive fee and an award fee.

2. Deriving the Award Fee and Incentive Fee from the Target Fee

Once the contractor has chosen their target fee, the Government must determine how much target fee to assign as incentive fee and how much to assign as award fee. The incentive fee is an objective formula that incentivizes the contractor to control costs. The award fee is a subjective incentive that a contractor may earn, in entirety or in part, during contract performance. The award fee portion of the target fee incentivizes the contractor for performance areas outside of cost including quality, schedule, and technical performance.

It is the contracting officer's job, in conjunction with the Government-integrated product team (IPT) and stakeholders of the product/service being acquired, to determine how much of the target fee should be dedicated to controlling costs and how much should be dedicated to controlling areas other than cost. Once the contracting officer knows these percentages, the contracting officer should enter this information into the TRIM to determine the value of the incentive fee and award fee. Figure 12 is a snapshot of both the TRIM contract menu and the administrative function that determines the incentive and award fee pools. In this particular example, the contractor selected the contract menu option with a target fee of $4,607, shaded in yellow, in the profit pool column of the contracts menu. The Government IPT believes cost control is important enough to warrant 40% of the overall target fee, so the contracting officer enters 40% into the incentive fee input cell and 60% into the award fee input cell. The input cells are shaded in yellow on the left-hand side of Figure 12. After incentive and award fee percentages are entered into the TRIM, it automatically determines the dollar values of both the incentive and award fee pools. In this example, the potential incentive fee pool ($1,843) and the potential award fee pools ($2,764) are shaded in yellow at the bottom of Figure 12.

TRUTH-REVEALING INCENTIVE MECHANISM

CONTRACTS MENU INPUTS

		Cost Target	Share Ratio	Profit Pool	Cost Total	Profit % of Proposed Cost Target	Profit % of Chosen Cost Target
Contractor Proposed Target Cost	$ 35,000.00	$31,500	0.600	$ 5,906	$ 37,406	16.9%	18.8%
Cost Target Bounds (%)	10%	$32,000	0.568	$ 5,614	$ 37,614	16.0%	17.5%
		$32,500	0.536	$ 5,338	$ 37,838	15.3%	16.4%
Target Fee	12%	$33,000	0.504	$ 5,079	$ 38,079	14.5%	15.4%
Max Share Ratio	0.6	$33,500	0.471	$ 4,835	$ 38,335	13.8%	14.4%
Min Share Ratio	0.15	$34,000	0.439	**$ 4,607**	$ 38,607	13.2%	13.6%
		$34,500	0.407	$ 4,396	$ 38,896	12.6%	12.7%
		$35,000	0.375	$ 4,200	$ 39,200	12.0%	12.0%
		$35,500	0.343	$ 4,021	$ 39,521	11.5%	11.3%
		$36,000	0.311	$ 3,857	$ 39,857	11.0%	10.7%
		$36,500	0.279	$ 3,710	$ 40,210	10.6%	10.2%
		$37,000	0.246	$ 3,579	$ 40,579	10.2%	9.7%
		$37,500	0.214	$ 3,463	$ 40,963	9.9%	9.2%
		$38,000	0.182	$ 3,364	$ 41,364	9.6%	8.9%
		$38,500	0.150	$ 3,281	$ 41,781	9.4%	8.5%
Budget	$60,000.00						

ADMINISTRATIVE		Profit Pool	Incentive Fee	Award Fee
		$ 5,906	$ 2,363	$ 3,544
		$ 5,614	$ 2,246	$ 3,369
Incentive Fee % of Target Fee	40%	$ 5,338	$ 2,135	$ 3,203
Award Fee % of Target Fee	60%	$ 5,079	$ 2,031	$ 3,047
		$ 4,835	$ 1,934	$ 2,901
		$ 4,607	$ 1,843	$ 2,764
		$ 4,396	$ 1,758	$ 2,637
		$ 4,200	$ 1,680	$ 2,520
		$ 4,021	$ 1,608	$ 2,412
		$ 3,857	$ 1,543	$ 2,314
		$ 3,710	$ 1,484	$ 2,226
		$ 3,579	$ 1,431	$ 2,147
		$ 3,463	$ 1,385	$ 2,078
		$ 3,364	$ 1,346	$ 2,019
		$ 3,281	$ 1,313	$ 1,969

Figure 12.   TRIM-based Administrative Function

3.   Administering the Incentive Fee

After dividing the overall contract target fee into an incentive fee pool and an award fee pool, they must be kept separate. The incentive fee pool and the award fee pool will be distributed at different times, in different manners.

The incentive fee is based on how well the contractor's target cost matches the contract's actual costs. If the contract's actual cost is the same as the target

cost, then the contractor will receive the entire incentive fee. Using Figure 12 as an example, the contractor would receive the entire $1,843 if the target cost and the actual cost were both $34,000. If the actual cost ended up lower than the target cost, then the contractor would receive the entire incentive pool plus a portion of every dollar that the actual cost was lower than the target cost. The equation that represents the incentive fee function is:

$$F = I + S\ (T\text{-}A)$$

where:
F = Actual incentive fee earned by the contractor,
I = Target Incentive Fee,
S = Share ratio,
T = Target cost, and
A = Actual cost

Using Figure 12 as an example, if the actual contract cost is $33,000 and the contractor's target cost was $34,000, then the contractor would earn the entire target incentive fee ($1,843) plus their share (.439) of the $1,000 under-run ($1,000 x .439 = $439). This gives the contractor an actual incentive fee of $2,282.

If the actual cost is greater than the target cost, then the contractor's actual incentive fee would be the target incentive fee minus the contractor's share of the over-run (if A > T in the formula above, T – A < 0). Using Figure 12 as an example, if the actual contract cost was $36,000 and the contractor's target cost was $34,000, then the contractor would earn the target incentive fee ($1,843) minus their share of the over-run ($2,000 x .439 = $878). In this case, the contractor would earn an actual incentive fee of $965 ($1,843 – $878 = $965).

The problem with incentive fees is that you cannot determine actual costs until the end of the contract when the product/service has been delivered and the contract has been closed. Waiting until contract closeout can be too long a wait for a contractor to receive fees. Therefore, incentive fee payments should be made

throughout the duration of the contract based on estimations of how the contractor is controlling costs. For example, the contractor should submit cost vouchers to recoup their actual costs of labor, materials, etc., throughout the duration of the cost-reimbursement contract. The contracting officer should award incentive fees based on the percentage of costs. For example, if the contractor submits a cost voucher for 10% of the contract value, then 10% of the target incentive fee should be up for consideration. The contracting officer should use earned value management data, specifically the cost performance index, to determine the portion of the accrued target incentive fee to award the contractor. For example, a contractor has selected a contract from the TRIM contract menu with a target cost of $34,000, a share ratio of 0.439, and a target fee of $4,607. Of that target fee, $1,843 is dedicated to the target incentive fee pool. If the contractor submits a cost reimbursement voucher for 10% of the contract value ($3,400), then 10% of the award fee pool should be considered for determination ($184). If the current earned value management data states that the actual costs are aligned with the budgeted costs (the cost performance index is 1.00), then the contracting officer should award the full 10% of the target incentive fee pool ($184).

Remember, these interim incentive fee payments awarded to the contractor are only estimates. Once the contract is closed out and actual costs can be determined, the incentive fee awarded should be adjusted accordingly. If the contractor's incentive fee payments exceed what they have actually earned, then the contractor will need to return the overpayment to the Government.

4. Administering the Award Fee

The award fee is a subjective incentive that a contractor may earn in its entirety or in part during contract performance. The award fee portion of the overall target fee is intended to incentivize the contractor for performance areas outside of cost such as quality, schedule, and technical performance. The contracting officer should work with all acquisition stakeholders to determine which areas of contractor performance, outside of cost control, need incentivizing.

The step-by-step instructions on how to set-up an award-fee plan are highly involved and outside the scope of this user's guide. Refer to your Government agencies' instructions on award fee to determine how to properly set-up the award fee portion of the overall target fee. If your agency does not have an award fee guide, our suggested reference is the Department of the Air Force *Award Fee Guide*, located in the AT&L Knowledge-sharing System of the Defense Acquisition University website (https://akss.dau.mil/Lists/Guidebooks%20%20Handbooks/).

5.   **The Relationship between the Incentive and Award Fees When Using the TRIM**

For the TRIM to create truth-revealing incentives, the incentive fee pool and the award fee pool must be tied together. The contractor's share of a cost over-run can eat away both the cost incentive and award fee pool. The TRIM mechanism is based on the total target fee and the contractor-sharing ratio. Even though we have divided the total fee into a cost incentive pool and an award fee pool to incentivized areas other than cost, the contractor share ratio is tied to the total target fee; if the cost over-run is large enough, then it depletes both pools.

The contract should be structured so any cost over-run is subtracted from the incentive fee portion of the total fee first. If the cost over-run is so large that it eliminates the entire cost incentive fee, then the cost over-run must be subtracted from the award fee pool. On the other hand, if the contractor is under-running the contract, then all additional fees are awarded as part of the incentive fee pool, not the award fee pool. Adding the contractor under-run fees to the award fee pool would be unfair because the contractor would have to earn the cost-savings fee twice.

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